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REPORT OF THE CHIEF OF THE BUREAU OF BIOLOGICAL SURVEY

United States Department of Agriculture,
Bureau of Biological Survey,
Washington, D. C., August 31, 1931.

Sir: I present herewith the report of the Bureau of Biological Survey for the fiscal year ended June 30, 1931.

Respectfully,

Paul G. Redington, *Chief.*

Hon. Arthur M. Hyde,
Secretary of Agriculture.

THE PROGRAM IN WILD-LIFE ADMINISTRATION

Progress was registered during the year 1931 in all lines of work for which the Bureau of Biological Survey is responsible. The review of the bureau's operations for the year concerned with wild life can be best interpreted with a background of 45 years of work in the field of research and in the conservation and control of the country's natural resources in wild life.

Originally established in 1885 to study the food habits and the geographic distribution of birds, within a year the unit became a recognized research agency in economic ornithology and mammalogy. This work has been continued to the present, and the Bureau of Biological Survey now has assembled voluminous data on these lines as they affect not only the wild birds and mammals of North America but to some extent the amphibians and reptiles also. Each year it publishes bulletins and other reports on the results of its research, service, and regulatory activities.

In the course of the years there were added to its responsibilities functions connected with game protection and the enforcement of Federal laws on that subject. The long series of annual publications on the game laws prepared by the Biological Survey record the advances made in this field, both in the administration of Federal laws and in the influence this work has had on the trend of State wild-life protective legislation.

Advances in earlier conservation activities and the assumption of new functions may be noted in the bureau's annual publications on Federal and State fur laws, in its scientific investigations for the benefit of the fur-farming, rabbit-raising, and reindeer industries, and in its research on and efforts to combat the diseases that affect the various wild-life forms. The expansion of economic functions as an effective aid to the work of the department in the interests of farmers and stockmen has included organized coordination and lead-

ership in activities for the control of predatory mammals and other economically injurious forms of wild life.

With the essential economic functions performed as effectively as the facilities have permitted, the bureau has strengthened and enlarged its work on research and other lines. The advances registered in conservation work through educational methods and law enforcement are readily apparent when the beneficial results from the administration of the migratory bird treaty act are considered. After 15 years' experience with the treaty, the period for which the international obligation was entered into with the proviso that it should continue automatically thereafter from year to year, there has been no serious demand for any lessening of its restrictive terms or for other changes in the direction of liberalized hunting provisions.

Gratifying progress in the wild-life conservational work of the bureau is being achieved in setting aside for the benefit of marsh and aquatic birds and other wild-life forms large areas of their habitat. The next few years should record the reservation of numerous suitable tracts of the public domain, or privately owned areas of land and water acquired by purchase or lease, as inviolate sanctuaries for migratory game birds, and this will benefit also numerous other valuable and interesting forms of wild life.

In the prosecution of work of such varied character by a bureau of any government, it is only to be expected that both constructive and destructive criticism should be heard. The Biological Survey has experienced a full measure of this, as its work has run counter to the wishes or interests of various groups. Profiting by suggestions offered for the more satisfactory accomplishment of its aims, however, the bureau in its administration of the wild-life resources seeks to serve the best interests of the animals and birds and of the people of the whole country. It is working both for the preservation of valuable, interesting, and harmless species and for the control, without extermination, of such species as locally become overabundant and economically injurious.

The idea of extermination of any form of the native fauna is abhorrent, and though misinterpretation of the purposes of the Biological Survey in the prosecution of its control work may lead to the impression in some quarters that the extermination of some species is sought, such impressions are fallacious. The bureau continues its work for the welfare of wild life, convinced that, though some forms must be curbed to prevent overabundance and undue interference with human economy, the perpetuation of representatives of all forms in their natural habitats will lead in the end to an increased appreciation of both the esthetic and the economic importance of conserving these valuable natural resources.

PRINCIPAL EVENTS OF THE YEAR

Work newly inaugurated and other accomplishments that have been of outstanding importance are briefly summarized as follows:

Discovery of the cause of the duck sickness that has been prevalent in the West, and its definite assignment to the field of bacteriology rather than of chemical (alkali) toxicity.

Amendment of the regulations so as to reduce the kill of wild fowl, by shortening the season 15 days (later cutting it to one

month), closing specified areas to goose hunting, including brant in the goose bag limit, limiting the number of live-goose decoys at a stand, and prohibiting mourning-dove shooting over baited fields.

Completion of examination and valuation surveys of 1,796,158 acres of lands recommended as suitable for migratory-bird refuges, and authorization by the Migratory-Bird Conservation Commission of four additional purchases of areas recommended by the bureau for acquisition as refuges.

Reintroducing musk oxen into Alaska by successfully transplanting a herd of 34 from Greenland.

Beginning a cooperative study of the muskrat on the Eastern Shore of Maryland, to develop information regarding this valuable fur bearer under natural and controlled conditions.

Congressional approval of the so-called 10-year program of predatory-animal and rodent control, and authorization of appropriations therefor not to exceed $1,000,000 annually.

Establishment of regional plan of supervision in predatory-animal and rodent control.

Creation of a new unit in the bureau to consolidate the wild-life disease investigations formerly handled in separate divisions.

Institution in Virginia of a cooperative study of diseases of upland game birds.

CHANGES IN ORGANIZATION

Three changes in organization, or completion of preliminary arrangements, have been effected during the year—an improvement in supervision of work for predatory-animal and rodent control; establishment of a field research project as a further guide to control policies; and consolidation of all wild-life disease investigations in one unit.

REGIONAL SUPERVISORS OF CONTROL WORK

To effect closer contact between the Washington and field offices in predatory-animal and rodent control, to accomplish more efficient work, and more closely to correlate bureau policies and field practices on the subject, a regional plan of organization was adopted, effective January 1. Four field leaders experienced in control supervision were selected to act as liaison officers and were designated regional supervisors. Their regions are as follows: Region No. 1, all States east of the Mississippi River, and Louisiana; region No. 2, Montana, Wyoming, South Dakota, Colorado, and Utah; region No. 3, Washington, Oregon, Idaho, Nevada, and California; and region No. 4, Arizona, New Mexico, Oklahoma, Arkansas, and Texas.

FIELD SUBLABORATORY IN FOOD-HABITS RESEARCH

Preparations were made during the year for opening a new sublaboratory of the Division of Food Habits Research at Denver, Colo., on July 1, 1931. Research workers trained in the analysis of stomach contents of birds and mammals are being transferred from the Washington laboratories to begin systematic laboratory and field studies of the food of predatory and other mammals and other forms of wild life charged with being economically injurious. Through identification of the items of food found in the stomachs it will be possible

to determine its nature with scientific accuracy, and, in conjunction with field investigations, to fix the economic status of wild mammals having injurious tendencies. In the same manner, in the past 45 years the Biological Survey has built up and organized data in the Washington laboratories to demonstrate the economic status of various species of birds. Research centering in the new laboratory is expected to give definite answer to questions raised on the relative good and harm done by mammals that over their general range have locally outstanding injurious tendencies.

WILD-LIFE DISEASE INVESTIGATIONS

On February 3, the Secretary of Agriculture authorized the merging of all of the bureau's research on diseases of wild animals and birds. Investigations of wild-life diseases formerly had been conducted by the Divisions of Biological Investigations, Food Habits Research, and Fur Resources. It is the object of the new unit to coordinate the study of diseases of wild birds and mammals, both by laboratory and by field investigations, in order to determine their causes and relationships, and methods of control. The work is essential to the conservation of waterfowl that suffer from diseases on concentration areas and on game farms; to the welfare of big-game and other species on preserves and in the wild; and to the raising of fur animals, reindeer, and other wild stock under conditions of semi-domestication. Under this new project the activities already in progress are being continued, and others will be added as occasion demands and facilities become available. J. E. Shillinger, a veterinarian with training in the Bureau of Animal Industry and with several years' experience in the Bureau of Biological Survey in studying diseases of foxes and other fur-bearing animals that are reared on fur farms, has been placed in charge of the new unit. A discussion of work along this line formerly conducted in the several divisions of the Biological Survey is brought together under one heading in this report.

INVESTIGATIONS OF HABITS AND RELATIONSHIPS OF WILD LIFE

FUNDAMENTAL RESEARCH REQUIRED

Research in the life habits, geographic distribution, migration, and classification of the many species of wild birds and mammals, which is essential to a full understanding of their relationships to their environment and of their economic status, has been continued on an increased scale during the year. Interest in the subject is becoming ever more widespread, and data on matters that have an influence on the well-being of the birds and the mammals of the wilds are continually made use of by the general public and by officials entrusted with the protection or regulation of the various species.

As the Federal agency that is concerned primarily with the higher forms of life, the Bureau of Biological Survey is constantly called upon to furnish basic information on their habits and relationships, their diseases and parasites, and the food available to and preferred by the various species. It is incumbent upon the bureau to develop

as expeditiously as possible information on all pertinent phases of these questions. Full cooperation is maintained with related Federal and State institutions.

BIOLOGICAL INVESTIGATIONS OF INJURIOUS SPECIES

Several field naturalists were detailed during November and December to study the effect on other species, of field operations for the control of wild animals injurious to agriculture and stockraising, and to game and other forms of the wilds. The observations were made in cooperation with control workers of the bureau and with members of a committee of the American Society of Mammalogists, mention of the results of which is made in connection with the report on predatory-animal control.

BIOLOGICAL RESEARCH IN THE WILD LIFE OF FORESTS

Studies of the relation of birds, mammals, and other vertebrates to forest production, under the McSweeney-McNary Act, have progressed satisfactorily during the year. From field headquarters established near Asheville, N. C., Amherst, Mass., St. Paul, Minn., and Ogden, Utah, research is carried on in the various types of forest areas. Though in their preliminary stages, these studies have already justified themselves. They have afforded an increased grasp of the importance of carefully planned investigations of all the varied forest habitants' relation to the forest and to one another. They have shown that without a more complete knowledge of this broad subject, the forests can not be made to yield their maximum output in commercial, esthetic, and recreational values.

A general review of the more important deer, antelope, and elk ranges of southeastern Arizona, with special reference to the relation of the game to forage and forest cover, was made during the year in collaboration with the Forest Service, and a mimeographed report thereon was issued in May. The evidence indicated that, owing to overprotection of these species, all have increased in certain areas until serious injury to forage is already resulting and the destruction of forest cover and food-producing capacity on a large scale is threatened. The reduction in numbers of the animals on particular areas was recommended.

Further studies of the Kaibab deer of northern Arizona were continued in June. It was found that most urgent need exists for the reduction of these animals to a point much below the present limited carrying capacity of the range and for maintaining the deer herd at this new level until the various species of shrubs and young trees upon which the animals depend for browse have become reestablished. The investigators also recommend that during this necessary period of reestablishment all forms of natural wild-animal life in this area other than deer be undisturbed, except for necessary scientific purposes or for protection where serious damage is being done to private property; that suspension of Federal and State predatory-animal killing be continued; and that the area be closed to private trapping and hunting of large flesh-eating animals until adequate annual reductions of deer are made.

LOCAL AND REGIONAL STUDIES

The report on the birds of Florida, publication of which is made possible by financial assistance from cooperators interested in forwarding the distribution of knowledge on birds, was in press at the close of the fiscal year. Issuance of this book will make available a comprehensive work on the ornithology of the State, of particular value because Florida is the only State containing any representation of the tropical fauna, and is important as a recreational center.

Field studies of the birds of Oregon were continued, and progress was made on the preparation of a report on the birds of that State.

Progress also was made on a report concerning the animal life of the Grand Canyon National Park, which is interesting to visitors drawn there by the scenic attractions.

During the early part of the fiscal year (July to September) detailed studies of the wild life in the region of the Upper Mississippi River Wild Life and Fish Refuge were carried on in Iowa, Minnesota, and Wisconsin.

A natural-history expedition to Haiti under the auspices of the Smithsonian Institution, in which the Bureau of Biological Survey participated, afforded opportunity to supplement the bureau's studies of the smaller migratory birds by observations on some of our species in their winter homes or en route to the United States from wintering places farther south. The two months spent on this work resulted in the addition of important data to the information files of the bureau.

Field studies of big-game species were made in several sections of the country, covering elk, deer, mountain sheep, and antelope, in the Western States; deer in Pennsylvania; wild life in general on State refuges in New York.

STUDY COLLECTIONS

Work done in Oklahoma during part of July added many interesting specimens to the mammal collection and, with those received from other sources, brought the total collected during the year to 564. In addition, voluminous field notes on the habits and distribution of mammals were added to the files. The specimens identified numbered 1,308. These came from individuals and institutions in 20 States and 1 foreign country. At the end of the year there were about 200,000 specimens of mammals and about 66,000 of birds in the Biological Survey collection.

Material for studies in progress by the bureau included 330 specimens borrowed from 11 scientific institutions in 9 States and 1 foreign country, and 236 specimens were lent to individuals and institutions engaged in mammal study in 5 States and 1 foreign country.

Fifteen new type specimens were added to the bureau's mammal collection this year, belonging to genera as follows: Tadarida, 1; Vulpes, 2; Felis, 2; Procyon, 6; Callospermophilus, 2; Ammospermophilus, 1; and Citellus, 1.

RESEARCH ON MAMMALS

ECOLOGY OF RODENTS OF THE SOUTHWEST

Studies of the ecology of small mammals, carried on mainly in Arizona and New Mexico, have been continued in cooperation with the Forest Service, the Universities of Arizona and New Mexico, the experiment stations and agricultural colleges of these States, the Bureaus of Entomology and Animal Industry of the Department of Agriculture, the National Park Service of the Department of the Interior, the Carnegie Institution of Washington, and the game and fish commissions of the two States.

The work of the year included continuation of studies of the relation of rodents to forest and range production, the species involved being principally rabbits, porcupines, and kangaroo rats. A report on the porcupine has been practically completed, and one on jack rabbits is in an advanced stage. Besides these special investigations, preliminary studies were made of all the mammal habitants of the Fort Valley Experimental Forest, near Flagstaff, Ariz.

Outlines for Studies of Mammalian Life Histories, Miscellaneous Publication No. 86, was issued during the year.

INVESTIGATIONS OF ELK IN WYOMING

Studies in the Jackson Hole region have been continued, with special reference to the life history of the elk, including the effect of predators on the herds, the diseases and parasites of the animals (p. 21), and the various kinds of food available and acceptable to them. Observations on all material obtained indicated that probably five-sixths of the elk cows bear calves, though this conclusion may be modified when more animals can be examined.

In the course of the elk investigations, studies were made of other animal life encountered, including moose, deer, mountain sheep, and antelope, and trumpeter swans and other waterfowl. Cooperation in these studies was maintained with the Forest Service and the Bureaus of Plant and Animal Industry of this department, the National Park Service of the Department of the Interior, the University of Wyoming, and the State Game Commission. An account of the studies of the elk in Jackson Hole was published in the Yearbook of Agriculture for 1931 (pp. 209–211).

STUDIES OF INTRODUCED MUSK OXEN

In the summer of 1930 the 34 musk oxen—15 males and 19 females—obtained from a Norwegian dealer, who had captured them in northeastern Greenland, were successfully taken to Alaska. Seventeen were calves of the year, and the others ranged up to about 2 years old. Arriving in New York after passage from Greenland to Norway and thence across the Atlantic, they were held in quarantine a little more than a month in order to observe whether they bore any diseases that might be inimical to other species of wild animals or to

domestic stock. They were then transported by rail to Seattle, Wash., by steamer to Seward, Alaska, and again by rail to College, near Fairbanks. A description of the musk ox, with an account of the reestablishment of these animals in Alaska, was published in the Yearbook of Agriculture for 1931 (pp. 398–402). Two of the animals suffered accidental and fatal injuries after they reached Alaska, but all others are apparently healthy and in good condition.

The musk oxen are being kept and studied in a large fenced inclosure. In cooperation with the Bureau of Animal Industry, three digestion tests have been made to determine the response to cultivated crops and range forage, the quantities required, the digestibility, both singly and in combination, and the practicability of fattening animals on crops raised locally.

It has been found that musk oxen are readily handled and worked as a herd. In fact, the local official in charge reports that they appear less difficult to drive and corral than reindeer.

REINDEER INVESTIGATIONS IN ALASKA

During the early part of the summer the bureau's representative in Alaska engaged on the reindeer work visited herders at points on the coast of Bering Sea and the Kuskokwim region, one result of which was the drawing up of tentative grazing rules for the protection of the range. A visit was made to Nunivak Island, where the progress in crossing of reindeer and caribou was studied. These experimental crossings are successful in improving the size of the reindeer, the crossbred animals being 50 to 100 pounds heavier than those of pure reindeer stock.

With additional fencing of four areas, covering 880 acres, at the experiment station near Fairbanks, there are now 15 inclosed pastures, aggregating 2,125 acres, in which to hold reindeer for observation and study and also such other species as musk oxen, mountain sheep, and caribou.

With the cooperation of the Bureau of Animal Industry good progress is being made in the study of reindeer nutritional problems and the utilization of various kinds of food necessary for the healthy development of the animals.

Representatives of the bureau attended the extended hearings held by a special committee appointed by the Secretary of the Interior, and at its request furnished information based on the investigational work on reindeer feeding, breeding, and management, and on grazing resources and management in Alaska. The committee in its report recommended that the reindeer research work now being carried on by the Bureau of Biological Survey be continued and extended.

Further study of the carrying capacity of the winter range substantiates figures previously obtained and demonstrates that during a winter period of six months one reindeer requires 18.9 acres of lichen-forage range, allowing a 30-year recovery period.

MAMMAL REPORTS

Progress was made on systematic studies of the mammals that have been collected in Lower California, and a systematic report on the mountain lions of both North America and South America

was practically finished. The results of various minor studies formed the subject of several systematic papers published in outside periodicals. During the fiscal year members of the staff described 14 mammals as new.

At the close of the year there was in press a detailed report (to be published as North American Fauna No. 53) on the mammals of New Mexico, based on data gathered by field parties of the bureau who have made biological surveys and life-zone investigations in that State over a long period of years. It will supplement a former publication in the series (No. 35) on the life zones of New Mexico and a report published cooperatively in 1928 on the birds of that State.

RESEARCH ON BIRDS

BIOLOGICAL INVESTIGATIONS OF MIGRATORY BIRDS

The lines of work that have been long established were continued, to the end that data on the classification, distribution, migration, and general habits of birds might be available.

The information files on the distribution and migration of birds received material additions during the year. Voluntary field workers, numbering about 670 and including migration observers and observers in the breeding-bird censuses, continued their cooperation; and their records—with those gathered from literature, data relating to specimens added to the bird collections, and records from regular employees—added nearly 69,000 cards to the information files, which now total about 1,770,000.

During the year it was a pleasure to send an engrossed testimonial of appreciation to eight bird-migration observers who for 40 years or more have been furnishing spring and fall reports to the bureau on the earliest, latest, and average dates of migration of the species as observed in their localities.

The quarterly reports of about 1,600 voluntary observers of waterfowl conditions were received, and the results were collated. Concern for the future of this important group of game birds makes it of paramount importance periodically to gather data on their abundance and on conditions affecting them on their concentration areas. Data thus obtained are supplemented by special investigations by field biologists so far as the facilities permit.

In the spring of 1931 an alarming condition of the waterfowl, which was rendered more acute by serious drought conditions, was reported from the northern Plains States and the region west to the Cascades and from the Prairie Provinces of Canada. The report prompted a concerted effort by the Bureau of Biolgical Survey and by Canadian officials to learn as much as possible about the situation. Field investigations were under way at the close of the fiscal year.

BIRD-BANDING STUDIES

Ornithological investigations through the medium of numbered bands are one of the most productive bird-study methods now known. During the year the number of bird-banding cooperators increased to 1,869, and these reported the banding of 169,279 birds. Returns and records of recapture totaled 12,329. The number of

birds banded since the inception of this work in 1920 is now well over 900,000.

As in previous years, special attention was given to the banding of waterfowl, of which 16,792 were banded during the year. At one station, on the Lake Malheur Bird Refuge in Oregon, the reservation protector in charge banded 3,500 birds, including about 50 whistling swans. Sportsmen were urged through the press to watch for banded birds in their bag and to report the numbers to the bureau, as an aid in studies of the abundance and flight routes of waterfowl.

Large numbers of bands also were placed on herons, shore birds, doves, hawks, owls, blackbirds, and members of other economically important groups. One cooperator at Chattanooga, Tenn., banded more than 13,000 chimney swifts, and as a result much valuable information already has been received.

Though the blue-winged teal has been regularly reported as breeding in the marshes bordering Chesapeake Bay, the first nest and eggs of this species known to science for this region were collected this season by a biologist of the bureau. His investigations also revealed that this valuable game species is a relatively common breeder in these marshes. The only other game duck breeding commonly on the Atlantic coast is the black duck.

An effort has been made to obtain basic information upon which to evaluate the work and equipment voluntarily supplied by bird-banding cooperators. With statements at hand from less than 25 per cent of those operating banding stations, it is found that these bird students have invested more than $20,000 in station equipment, while their annual contribution in time, figured conservatively at 50 cents an hour, amounts to more than $44,000. It is estimated that all the cooperators in this work have together invested at least $50,000 in traps and other equipment, and that the value of the time annually contributed (including those not reporting, on the above basis), is in excess of $125,000.

ECONOMIC STUDIES OF BIRDS AND MAMMALS

LABORATORY RESEARCH

FOOD OF BIRDS

As in other years, many analyses have been made of special lots of bird stomachs, mostly at the request of cooperators or correspondents. Some of the more important collections analyzed were of bobwhites from Missouri and Wisconsin; Hungarian partridges from Wisconsin and Washington; birds of prey from Wisconsin, Massachusetts, New York, Virginia, Oregon, and Ohio; red-winged blackbirds and horned larks from California; crows from New Jersey; nighthawks from Idaho; butcher birds from California; and a variety of species from Florida.

Revision of an earlier draft of an extensive report on fish-eating birds was continued, involving both new analyses and reexamination of numerous stomachs, and completing the examination of all stomachs of fish-eating birds on hand. In October a statement was issued through the press to correct erroneous impressions that have been

current regarding great blue herons and other fish-eating birds. Charges that these birds unduly destroy commercial and game fishes are often unfounded, except about fish hatcheries, where under permit they may be killed. On the other hand, they are found to consume such numbers of spawn-eaters that under natural conditions there is little doubt that in the aggregate they do more good than harm.

Work was continued on stomach examinations of the diving ducks, and analyses for a number of the species were completed. Somewhat more than 300 stomachs of this group of birds remain for examination before preparation of a report can begin. Investigation of the food habits of the ruffed grouse has been continued with a view to preparing for publication a comprehensive report on this subject.

FOOD OF PREDATORY AND OTHER MAMMALS

During the year, some 500 stomachs of mammals were examined, including about 150 of coyotes. The combination of laboratory and field investigations of the food of predatory mammals should yield information of value in guiding control campaigns. Near the end of the year preliminary plans were completed for establishing and equipping a sublaboratory of the Division of Food Habits Research in Denver, Colo., which will be headquarters for investigation of the food of western predators.

Technical Bulletin No. 224 on the Habits and Economic Status of the Pocket Gophers, was issued during the year, based largely on the food habits of the pocket gophers but treating fully other factors in their life history, including burrowing and its damage to crops, pasture, and forage, and the breeding and other habits of the rodents.

OTHER LABORATORY WORK

Work in the laboratory included maintenance and improvement of information files, identification of wild-duck food plants and of seeds for correspondents, and improvement of reference collections, especially of spiders, skeletal material, and seeds. The seed collection is now one of the best extant, comprising about 3,800 species of 1,200 genera, chiefly of native plants. All plants collected in Minnesota in connection with a survey of the food resources for wild fowl of that area were identified; studies and illustrations were made to facilitate identification of seeds found in bird stomachs; preparation of a reference herbarium of marsh and aquatic plants was continued; and available data on the bearing season of fruits attractive to birds were tabulated so as to be readily available.

FIELD STUDIES OF INJURIOUS BIRDS

Damage by birds has always been most pronounced where agriculture is being extended into new areas. The orchard planted in a clearing among the foothills or the rice field made in a marsh where formerly nature held entire sway is immediately recognized as a splendid source of food by the birds and other forms of wild life, which being abundant in such places do much more damage there than in older settled regions. This phenomenon accounts for the

serious situation with regard to destructive birds on the Pacific coast.

In California the linnet, or California house finch, by eating buds and fruits does damage that has been estimated to exceed a million dollars annually. Some of the other species of native sparrows add to the destruction. Horned larks cause losses second only to those chargeable to the linnet, but in this case it is to vegetable crops through the destruction of seedlings. Blackbirds and coots severely damage the rice crop of the State. The Biological Survey now has two investigators devoting their entire time to the study of destructive birds in California and developing methods of control. A satisfactory solution of the linnet and horned-lark problems has been reached. Because of their nomadic habits, blackbirds have proved notoriously difficult to control, but a campaign against them carried on during the breeding season seems the obvious way of reducing their destructiveness. The results attained in experimental work in the vicinity of Marysville have indicated that blackbirds can be reduced in numbers sufficiently to afford satisfactory relief to the rice growers.

The problem presented by coots apparently can be solved in part if hunters will recognize the food value of these birds (often called "mud hens") and utilize them more than has been customary in proportion to wild ducks, which are being endangered by hunting and adverse conditions on their breeding and other concentration areas. In the Yearbook of Agriculture for 1931 was published an article (pp. 542–544) on Wild-Fowl Conservation Furthered by Regulation and Educational Methods, one of the purposes of which was to make more widely known the demonstrated palatability of the coot. Further publicity to this matter was given through the press in September.

An investigator with headquarters in Washington has looked into reports of damage to houses in that State by flickers and depredations on oysters by gulls, neither of which cases proved to be serious. Reported depredations on corn by starlings and red-winged blackbirds were investigated in Kent County, Md., but the damage was found to be less noticeable than in former years.

FOOD SURVEYS OF MIGRATORY-BIRD REFUGE AREAS

Although work in preceding years made it possible to recommend for acquisition about two-thirds of the total number of migratory-bird refuges that it is thought can be acquired and supervised under existing legislation, inspections of newly recommended and other sites are being continued with the view of rounding out the program. During the fiscal year this work was carried on in New York, New Jersey, Maryland, Virginia, North Carolina, Florida, Indiana, Iowa, and Nebraska. The total number of prospective sites examined was 15, and the total acreage about 283,700.

Conditions on the large body of backwater created in the Mississippi River by the Keokuk Dam were studied in order to learn the probable effects, primarily on vegetation and secondarily on wild life, of the numerous dams which it is proposed to install in stabilizing water levels in the upper Mississippi. Provided fairly constant water levels are maintained, it is concluded, the effects of dams are

favorable. The Bureau of Biological Survey was represented at several hearings pertaining to the proposed creation of a 9-foot channel in the upper parts of the river.

Investigations were made on the Upper Mississippi River Wild Life and Fish Refuge to reveal the effects of prolonged drought on the flora and fauna. Their results, together with other conclusions relative to the refuge, were presented at a hearing held at Camp Minnewis, near Wabasha, Minn., before the special Committee of the Senate on Conservation of Wild-Life Resources.

Minor investigations of food conditions for wild fowl were made on the Potomac River below Washington and in northwestern Pennsylvania on request of persons locally interested.

A report was issued during the year (Technical Bulletin No. 221) on Wild Duck Foods of North Dakota Lakes, covering a botanical survey made to determine the wild-fowl food resources of that State. The important wild-duck foods native to the State are listed with annotations, and their tolerance to concentrations of salts is shown.

FOOD HABITS RESEARCH IN FOREST WILD LIFE

An investigator was assigned to the Northeastern Forest Experiment Station, at Amherst, Mass., to make a study of the relation of the food habits of birds and other vertebrates to the white-pine weevil and the white-pine blister rust. Work has been carried on during the year upon these and other wild-life problems in the New England States and New York, and in midwinter in the Washington laboratory.

STUDIES IN ATTRACTING USEFUL BIRDS

For the first time in the five years during which the project in attracting birds to the experimental chestnut orchard of the Bureau of Plant Industry at Bell, Md., has been carried on, a decrease was noted in the number of broods produced. The number of broods or partial broods to the acre for the first year (1926) was 6.8. In the following three years this figure rose steadily, as follows: 1927, 16; 1928, 18.5; and 1929, 25.4. In 1930 the number dropped to 19.4, and this decrease affected almost equally all the more prominent species. The number of broods of European starlings dropped from 35, the high figure of 1929, to 28; that of house wrens, from 33 to 23; and that of purple martins, from 10 to 7. These figures are for birds nesting in houses only and do not include tree and bush nesting species. The severe drought of 1930 may have been the cause of the decrease.

Farmers' Bulletin No. 1644, entitled "Local Bird Refuges," issued during the year, discusses plantings, water supply, structures, and other features found effective in attracting useful birds, and shows how farms, homesteads, and other suitable areas are benefited by being made bird sanctuaries.

COOPERATIVE INVESTIGATION IN GAME-BIRD MANAGEMENT

Throughout the year contact was maintained directly and by correspondence with the game-bird studies being carried on in cooperation with the Universities of Michigan, Wisconsin, Minnesota, and

Arizona as well as with the Williamston project in Michigan, where attempt is being made to find a satisfactory basis for farmer-sportsman relationships.

Preliminary surveys for the establishment of new projects in demonstrating methods of quail management were made during the year, though these may not actually be in operation before January, 1932; those most advanced are in South Carolina and Arkansas. A survey of conditions in Missouri was made as a basis for recommending a systematic plan for the introduction of ring-necked pheasants into that State.

To aid conservationists and sportsmen in safeguarding the stocks of upland game birds, a Bureau of Biological Survey mimeographed pamphlet (Bi–1099), Winter Feeding of Upland Game, was prepared and issued during the year.

The final report on the cooperative quail investigation carried on from 1924 to 1929 by the Bureau of Biological Survey and a committee of sportsmen was published in May. It is a volume of about 600 pages, fully illustrated, entitled "The Bobwhite Quail: Its Habits, Preservation, and Increase." It is being distributed by the quail committee—not by the Bureau of Biological Survey.

RESEARCH IN FUR-ANIMAL PRODUCTION

FUR FARMING

The prices paid for raw furs are influenced largely by the financial status of other industries, and in time of depression this commodity is one of the first to register a decline and generally one of the last to recuperate. There is, however, no overproduction of furs and no large supply of raw furs in storage. A general decline in the prices realized for raw furs, however, during the past three or four years, has led the bureau in its research work in this field to concentrate its efforts on economy of production on fur farms.

The investigations show that fur farmers who have small holdings and who depend for their income almost entirely upon fox production are spending as much as $30 to $40 to produce a silver-fox pelt. Those who are raising foxes in connection with some other enterprise or who have more than 100 pairs of breeding stock, may produce the pelts as cheaply as $20 each. Fur farmers who have been practicing strict economy in the conduct of their business and have been able to reduce overhead expenses, are realizing profits, while others have been gradually forced to discontinue operations. Experiments in fur-animal feeding and breeding have demonstrated that every effort must be made to direct and conduct fur farming in an efficient manner. This not only calls for the exercise of sound judgment on the part of the fur farmer in organizing his ranch, in selecting his breeding stock, and in conducting feeding and breeding operations, but also calls for continual close observance and study of all conditions surrounding the work.

An account of the bureau's participation in the International Fur Trade Exposition, held at Leipzig, Germany, in the summer of 1930, with a description of the exhibit, was published in the Yearbook of Agriculture for 1931 (pp. 270–272). At the close of the exposition the bureau's representative, who was appointed commissioner gen-

eral to represent this country at the Fur Trade Exposition and Congress, visited other countries of Europe to note developments and methods of fur farming abroad.

STUDIES OF GESTATION PERIODS

Since sufficient investigations and observations have not been conducted to determine the breeding and gestation periods of all the fur animals, the bureau is continuing this line of research with martens, fishers, and badgers, and plans to study other species as soon as facilities permit.

The birth in the latter part of April of 2 litters of martens, 1 male and 3 females, confirms the findings of previous years that the mating period is in July or August and that whelping takes place in April, indicating a gestation period of from 8½ to 9½ months. German scientists checking these results have established the fact that the same mating and gestation periods hold for stone martens, and Russians have found the same to be true of the Russian sable.

FUR LEGISLATION

Over a considerable portion of the United States, the marten does not exist in commercial quantities; in fact it is all but extinct in most of its former haunts. State laws should set on this fur animal a close season of sufficient duration to permit it to reestablish itself in sections where a few are still found or where the species can be reintroduced.

Fur tradesmen and fur farmers realize the necessity of action by State game commissions in protecting the wild-life resources for the people of the respective States. When, however, the necessity for more stringent regulatory measures became generally recognized, many fur laws were enacted without full consideration of the far-reaching economic problems involved. As a consequence, some laws now on the statute books are retarding the development of the fur industries without accomplishing the conservation purposes for which they were enacted. Those responsible for fur-animal legislation would do well to consult both students of conservation and representatives of trappers, fur farmers, and fur tradesmen before laws are drafted. As conservation commissions and State legislators come to realize the full importance of gathering basic facts from all sources, hearty cooperation in the conservation of the raw-fur supply will become more general.

The bureau issued during the year its annual summary of the fur laws of the United States and Canada for the season 1930–31 (Farmers' Bulletin No. 1648), and at the close of the year had partly prepared the manuscript for the 1931–32 publication.

MUSKRAT INVESTIGATIONS

During the past decade there has been considerable exploitation of investors in so-called muskrat-producing properties. To disclose the real possibilities of the business, experimentation with the animals has been undertaken, including detailed studies of their habits, both in natural marshes and in pens. A trained biologist conducted

these studies with muskrats obtained from various sources and confined in small pens of different types. Though a number of commercial raisers of muskrats have contended that it is possible to produce muskrat fur profitably in small pens, the bureau's investigations indicate that this can not be done. Investigations of marsh areas are also being made to determine the factors necessary to attain the maximum rate of muskrat production.

Financial conditions affecting the fur trade have caused many promoters to retire from the field of muskrat exploitation as well as from similar activities in other branches of fur farming.

FUR ANIMAL EXPERIMENT STATION, NEW YORK

The research work at the fur animal experiment station at Saratoga Springs, N. Y., has been confined mainly to feeding and breeding problems and to economical methods of producing fur. Much attention has been given by the bureau to the most desirable kinds of food and methods of feeding.

Experiments with liberal and limited feeding of female foxes during the fall and early winter have indicated that those fed liberally produce a greater number of young. Results of experiments to determine whether a vegetable-supplemented diet during summer and fall has a favorable influence on the breeding record of females are being continued.

Fox farmers are much concerned as to the cause of a rust or brown tinge in the pelts of silver and black foxes. The cause is generally attributed both to incorrect proportions of meat and cereal in the diet and to exposure to sunlight. Experience with "fur sheds," used to keep the animals out of the sunlight, demonstrates that a considerable percentage of silver and black foxes carry a decided tinge even when they are kept in a cool, shady pen from early in September until after the middle of December. Although the general observations made indicate that fur sheds may possibly have a slight value in controlling tinge, other factors than exposure to sunlight and the relative percentage of meat and cereals in the diet are responsible for the occurrence of tinged, or off-colored, pelts, and are yet to be found. The indications are that in the majority of cases the tendency is inherited, as are the woolly and "sampson" conditions.

RABBIT EXPERIMENT STATION, CALIFORNIA

When the United States Rabbit Experiment Station was established at Fontana, Calif., in 1927, facilities were provided for maintaining 140 breeding animals. These facilities have been increased so that during the past year approximately 204 unbred does, 52 mature bucks, 108 weaned young, and 550 nursing does were maintained at the station. In addition, 2,873 young were raised to weaning age; 1,804 were turned over to the cooperators as surplus; 300 were used in disease investigations in cooperation with the University of Southern California; 45 were used in breeding experiments in cooperation with the University of California; and 20 were given to the United States Dairy Experiment Station, at Beltsville, Md., for nutritional studies in connection with related studies of dairy cattle.

The average weight of breeding does on hand when the station was established approximated 7½ pounds. Through selective feeding and breeding the quality of this stock has been improved until the average weight of a breeding doe is now about 9 pounds. Production of meat has likewise been increased from an average of about 49 pounds to around 80 pounds per doe during the first year. The experiments strongly indicate that production can be still further increased by improved feeding and breeding methods.

MANAGEMENT STUDIES

Different systems of feeding and handling rabbits have been compared, with a view to economizing in the cost of production. Feeding experiments show that the most economical ration for producing rapid gains in meat rabbits consists of 80 per cent alfalfa hay and 20 per cent grain. Studies of handling rabbits have included comparisons of different types of hutches and shelters. A new unit equipped with all-metal hutches and two types of floors is being compared with similar hutches made entirely of wood. While the initial cost of equipment and installation of the metal hutches is slightly more than that for the same type made of wood, the indications are that the additional cost will be more than offset by the improved sanitary features and the elimination of repair bills.

The station is cooperating with the University of California, at Los Angeles, to determine the relative value of certain breeding factors influencing the quality of meat and fur produced.

A series of lantern slides (No. 268), with descriptive text, on the work of the rabbit experiment station, was prepared during the year, and cooperation was given the Bureau of Home Economics in the publication of a leaflet (No. 66) on recipes for cooking rabbit meat.

WILD-LIFE DISEASE INVESTIGATIONS

DUCK SICKNESS

Marked progress in the study of duck sickness in Western States was made during the year. The advance is not only gratifying to conservationists, who long have hoped for the solution of this problem, but it is of peculiar interest to students of avian diseases, in that the problem has been removed from the realm of chemical (alkali) toxicity to that of bacteriology. Following a lead obtained in investigations made in 1927, the scientists engaged in the study inaugurated a series of experiments that changed with dramatic suddenness its whole aspect and at length demonstrated the real nature of the disease.

The scene of the field studies of this problem again was the Klamath region of southern Oregon and the adjacent area about Tule Lake, in northern California. A temporary field laboratory at Klamath Falls, Oreg., served as headquarters and afforded facilities for direct experimentation with captive sick and healthy birds. At the outset of the season's work experiments were resumed along several lines of approach inaugurated in the previous season. Among these were attempts to produce the disease through the administration of natural and synthetic alkali combinations suspected to be causative

agents. In none of these were true symptoms of duck sickness produced. The possibility of the ailment being caused by the ingestion of certain salts of lead or by contact with toxic gases was given consideration and led to experiments that also yielded consistently negative results. Efforts to transmit or reproduce the disease by feeding body tissues of birds that had died of duck sickness and by the injection of blood sera and extracts of tissues of sick birds, were involved in other experiments, which, up to the end of July, 1930, likewise revealed no tangible evidence of the nature of the sickness.

During a period of hot weather near the end of July, however, a juvenile ring-billed gull, which was being fed copiously on the tissues of birds that had died of the disease, developed symptoms similar to those of duck sickness. A few days later mallards fed on the livers of birds that had died from the disease also succumbed. In these experiments no refrigeration facilities were available, and to this circumstance must be attributed the early discovery of the true nature of the disease. Tissues that were being fed soon decomposed under the high temperature prevailing, and the results attained indicated that some product of decay or some factor incidental to it was involved. Subsequent experimentation verified this hypothesis, and duck-sickness symptoms—including paralysis of wing, leg, and neck muscles, paralysis of the nictitating membrance, discharges from eyes and nostrils, difficulty in breathing, a lowered body temperature, and green diarrhea—all were accurately reproduced experimentally in many birds.

Further work demonstrated that the rapidity and severity of development of the symptoms appeared to be directly proportional to the quantity of toxic material fed; that the birds that recovered were simply those that had taken sublethal doses; that the "incubated" livers, kidneys, and even blood of birds that had died of the disease yielded a toxic product, which could be extracted with normal salt solution and injected into other birds to convey the disease; that the incubated tissues of healthy birds did not produce a similar toxin; that the process of transmission could be carried through a series of birds if a period of incubation or toxin production was permitted in the dead tissues of each successive bird killed; that boiling temperature destroyed the toxin if continued for five minutes; that recovery from a single attack of duck sickness did not establish a perceptible immunity; and lastly that incubated tissues of birds that had died at the Bear River marshes, Utah, produced symptoms identical with those occurring among the birds of the Klamath region of southern Oregon.

Such experimental evidence pointed strongly to the existence of a saprophytic, toxin-producing bacterium analagous to, if not identical with, one or another of the types productive of botulism. This theory was given further support when body tissues of birds that had died of the disease, and mud collected at Tule Lake, Calif., were sent to the Bureau of Animal Industry, and there the bacterium known as *Clostridium botulinum*, type C, was isolated from each. The toxin produced by this organism is known to be a cause of what is commonly termed "limberneck" in domestic poultry.

The discoveries are significant not only in the light of the earlier and radically different concept of this waterfowl disease, but also

from the viewpoint of the prevalence and distribution of *Clostridium botulinum*, type C. This organism has been associated primarily with local outbreaks of limberneck, with which small flocks of poultry sporadically become afflicted. If further evidence confirms present findings, the widespread epizootics among western waterfowl which, in the last two decades have killed millions of ducks, geese, shore birds, and other species, must be charged against this same organism. Therefore its importance as a factor in avian mortality becomes enhanced manyfold.

Despite the presence of this bacterium in the tissues of birds and in lake mud, and notwithstanding the accuracy and consistency with which the symptoms of botulism have been reproduced on many occasions in the manner described, there still remains the task of demonstrating the existence of toxin under field conditions in food or water likely to be consumed by birds. This will constitute the major objective of the coming season's work on this line. There is also the need of further identification of samples to determine whether this avian disease is produced exclusively by this one type, C, or whether the other strains known as types A and B, highly lethal to human beings, may not occasionally be involved. Furthermore, it is essential to gather material from as many as possible of the duck-sickness areas in order that the whole problem may be properly appraised and correlated through bacteriological evidence.

With respect to remedial measures, it is gratifying to note that steps taken to eliminate high concentrations of alkaline water are equally effective in combating botulism. Toxin production is favored by high temperatures, shallow water, and conditions usually found on mud flats, with attendant decay of animal and vegetable matter. Duck sickness is brought under control when these conditions are eliminated and areas of deep fresh water of constant level substituted.

UPLAND GAME-BIRD DISEASES

Through the provision of funds and other facilities of a cooperator interested in quail and other game birds, it has been possible to begin an intensive study of diseases of upland game birds. This work is being conducted by cooperative arrangement largely on the White Oak quail farm and on the Virginia State game farm near Richmond. Arrangements have been made for the use of the State laboratories at that place as a field station for diagnostic work. During the hatching and brooding season of 1930 extensive losses of young quail were experienced, but up to June 30 the serious diseases of the previous year were not in evidence and comparatively little loss was suffered.

With the increasing shortage of game in many sections of the country it is evident that a sustained effort will be made to produce certain species of upland game birds under controlled conditions. Thus far it has been determined that disease is the limiting factor in actual success in controlled propagation of quail. It is the object of those engaged in this new field of research to develop as rapidly as possible means of controlling losses from nutritional, bacterial, and parasitic diseases.

FUR-ANIMAL DISEASES

The cooperative work at the University of Minnesota on diseases of fur animals has been continued, and efforts are being concentrated on perfecting methods of producing a more effective artificial immunity against fox encephalitis and fox paratyphoid by means of vaccination.

Several outbreaks in foxes of diseases not heretofore encountered have been under observation, and investigations are under way to identify the causative organisms with a view to initiating satisfactory control measures. Numerous specimens of animals collected from fur farms throughout the country have been examined in detail. Since a requisite to the study of any new infectious disease is the ability to reproduce it in a series of animals by recovery and introduction of the infectious organism into susceptible subjects, a great many test animals were used in these transmission experiments.

A special effort is being made to ascertain whether true canine distemper is a natural disease of silver foxes or whether these animals are subject to a similar but not identical infection.

At the bureau's fur-animal experiment station at Saratoga Springs, N. Y., further field observations were made on disease conditions of fur animals. It was found that foxes, especially young pups, are very susceptible to poisoning from creosote, a substance present in many products commonly used in staining houses and other structures.

Extended investigations on the control of lungworm infestation in foxes showed that in controlling one species, *Eucoleus aerophila*, treatment of the foxes with the tracheal brush at intervals of two or three weeks is a valuable supplement to sanitation. It has been found necessary, however, to remove the animals from the source of contamination, as in the pens the eggs of this parasite remain viable for a long period. In one case it was found that animals were infested when placed in a pen that had been unoccupied for 18 months. The brush treatment is ineffective against the species known as *Crenosoma semiarmatum*. Losses from lungworm infestation in foxes are more numerous than is ordinarily believed. Microscopic examination of the lung tissues of heavily infested animals showed miliary tubercles and chronic broncho-pneumonia to be common.

One serious outbreak of disease in a large minkery was studied. Extensive losses among the minks were caused by coccidiosis, the protozoan parasite being more generally fatal to kits than to adults. No treatment of value has been developed, but the losses subsided when the animals were removed from the source of contamination. Keeping the minks in pens with wire floors so that all waste products can fall through has proved effective in controlling infestation. Post-mortem examinations on minks frequently showed liver and intestinal fluke infestation, both in minks trapped in the wild and in those from minkeries where fish had been fed in the raw state. Infestations with the fluke *Parametorchis canadensis* in the gall bladder and bile ducts of minks commonly cause cirrhosis of the liver. It is indicated that fresh-water fishes serve as intermediate hosts of this parasite and that where sources are contaminated control may be accomplished by avoiding the use of such food uncooked.

DISEASES OF DOMESTIC RABBITS

At the University of Southern California a cooperative study of diseases of rabbits is being conducted under arrangements made through the bureau's rabbit experiment station at Fontana. The cooperation will be continued for the benefit of the rabbit-raising industry and as an aid to studies being made at the experiment station.

In July, 1930, a highly infectious disease reported in 12 rabbitries in the vicinity of Santa Barbara, Ventura, and San Diego, was identified as infectious myxomatosis. This had previously been known to occur locally in South America, and recently it has renewed its activity in the California localities named and also in the immediate vicinity of Los Angeles. Recommendations for control through quarantine and sanitation have been made, and experiments have been carried out in an attempt to immunize rabbits against the infection by means of vaccines. A completely satisfactory vaccine has not yet been developed, though the desired results are obtained under some conditions.

Extensive studies on coccidiosis have been made. Several species of coccidia are known to infest rabbits, and some of these are highly pathogenic. The complete life cycle of one, *Eimeria magna*, has been studied, and similar studies of others are in progress.

Subcutaneous abscesses are common among animals kept in commercial rabbitries, and research by the bureau on this condition has revealed organisms that upon subcutaneous inoculation reproduce typical abscesses in normal rabbits. The studies will be continued with a view to developing measures of control.

About 300 rabbits were employed for the disease investigations. In 50 post-mortem examinations made for commercial rabbit producers, the majority of the animals had died of myxomatosis, coccidiosis, or the condition known as bloat.

DISEASES OF WYOMING ELK AND OF REINDEER

Detailed studies of phases of the disease situation confronting the elk of the Jackson Hole region, Wyoming, need further attention but could not be undertaken during the period while the animals were on their wintering grounds, as the season passed with practically no mortality in the herds. Scabies was found somewhat prevalent among the herds.

Cooperation with the Bureau of Entomology is being continued in the study of warble flies and other insect parasites of reindeer, and means of relief.

PREDATORY-ANIMAL AND RODENT CONTROL

INFESTED PUBLIC LANDS

Settlers on western lands, seeing the profits of their work wiped out by such predators as wolves, coyotes, mountain lions, and bobcats, and such rodents as prairie dogs, ground squirrels, pocket gophers, and jack rabbits, have continued to appeal to the Federal Government, whose lands serve as breeding reservoirs for these predators and rodents, to prevent their incursions on private lands

brought under economic use. In order to establish and maintain their homes and to raise crops and livestock at a profit, farmers and ranchers of the West have resorted to various methods and have used every resource at their command to keep in check the injurious rodents that destroyed their crops and forage and the predatory animals that annually took a heavy toll from their herds and flocks. Without the aid of the Government, however, all that they could do, either single handed or by community effort, did not prevent the destroyers from the public domain from reinfesting stocked and cultivated areas.

The Biological Survey's entrance into the work of control came as a result of these insistent demands for aid against the predatory animals and injurious rodents on the public lands and for assistance in devising satisfactory methods of control as a form of agricultural relief. During the 16 years of the bureau's work on this line with States, counties, organizations, and individuals, it has furnished leadership in both organization and methods and also has accepted responsibility for the control of injurious wild animals on Federal lands.

LEADERSHIP AND COOPERATION IN CONTROL

Since the Bureau of Biological Survey began to participate in control operations individuals, officials, and organizations connected with farming and the livestock industry and interested in game protection, have continued to seek the aid of the bureau. State, county, and local organizations have manifested a hearty spirit of cooperation in the work. The Biological Survey has never attempted to assume responsibility for the complete control of mammal pests in all regions, but it has regarded assistance in the control of wild animals where they become an economic liability as a phase of the service of the Department of Agriculture to the agricultural industry, and has felt a definite responsibility to farmers and stockmen to render that assistance. It has been definitely helpful in organizing the work and in correlating control activities in the several States.

Miscellaneous Publication No. 115, Information for the Guidance of Field Men and Cooperators of the Bureau of Biological Survey in the Control of Injurious Rodents and Predatory Animals, issued in April, discusses the general policies of the Biological Survey on control operations and, with regard to field practices, outlines definite instructions for men working under the supervision of the survey and for cooperators of the bureau working under its leadership.

COOPERATIVE FUNDS AND ORGANIZATION

Federal and cooperative funds available during the year permitted organized field work in the control of predatory animals and injurious rodents in 40 States. Federal funds available totaled $607,360, of which $35,752 was used in research in control methods; $340,110 in the control of predatory animals; and $231,498 in the control of rodents. The States provided $470,779 for use in cooperative control operations, while counties, livestock associations, and individuals spent $404,062 for poison and labor in campaigns conducted under the supervision of bureau field leaders, and for poison prepared by

the bureau. This was exclusive of the rodent work in California, where counties and individuals spent $507,914 for rodent-control purposes, the work on private lands being largely supervised by State and county officials. Thus the total advanced by cooperators for conducting organized control campaigns was $1,382,755; consequently their contributions exceeded the funds appropriated from the National Treasury in the proportion of more than 2 to 1.

The Federal Government materially increased the effectiveness of its control operations through an emergency appropriation made late in the year under the provisions of the construction and employment program. The $202,645 appropriated under this measure provided 36,056 days of labor in the aggregate for predatory-animal and rodent control. Thus the bureau was enabled to prosecute additional rodent-control work on the public domain for a brief period and to extend further cooperation in the way of supervision to private landowners. The emergency appropriation also enabled the bureau to employ additional hunters during the spring months, when effective work could be done against predatory animals on lambing ranges and other areas where at this season they are particularly destructive.

State appropriations for predatory-animal and rodent control work in cooperation with the bureau during the coming biennium were made (in amounts equal to former appropriations) in 16 States. These States are Washington, Oregon, California, Nevada, Utah, Arizona, New Mexico, Colorado, Wyoming, Idaho, Montana, Oklahoma, Arkansas, Texas, Wisconsin, and Michigan. Cooperative funds in Alaska were withheld by recent action of the Territorial legislature, because of the economic situation. In Nevada a slight increase in funds over the past biennium became available on January 1. New legislation appropriating $10,000 a year was passed in Missouri, and the bureau has been requested to enter into cooperative wolf control there. In view of the financial situation throughout the country the appropriations that were made speak well for the effectiveness of the cooperative control program and evidence the satisfaction of the States with the leadership of the Biological Survey in the work.

During the year plans were developed for the establishment of a new rodent-control district, comprising the States of Florida and Georgia, and for assigning a rodent-control expert to this territory, from which there has been an insistent demand for aid.

In Tennessee assistance in predatory-animal control was rendered this year to farmers whose sheep and other livestock were suffering depredations by coyotes and wild dogs. A hunter was transferred from the Oklahoma-Arkansas district to Hickman and Maury Counties, Tenn., to survey the situation and take appropriate action.

A joint survey of the rodent infestation on all Indian reservations of the Western States was undertaken by field agents of the Indian Service and the Bureau of Biological Survey during the past year. Data will be obtained therefrom for use as a basis in estimating the expense of undertaking extensive control operations on Indian lands, both to improve grazing and agricultural conditions on the reservations and to prevent the reinfestation of adjoining private holdings.

Two changes in bureau control organizations have been noted in the introductory paragraphs. Effective January 1, the country was divided into four major regions, each under competent supervision

and each embracing four or more of the original control districts, the purpose being to correlate the control work better throughout the country and better to insure the execution of administrative directions and policies.

UNIFORMLY MIXED RODENT BAITS

In order that a standard uniform bait of high quality may be available at low cost for use by district leaders of rodent control on public lands and by cooperators, a bait-mixing station is maintained by the Biological Survey at McCammon, Idaho. The grain used for the baits is steam rolled and thoroughly cleaned. Part is shipped to various districts for poison treatment in the field or at district mixing plants, but a large proportion of the total output is so treated at the central station and from there is shipped to the various districts for local distribution. During the past year this plant shipped to leaders or cooperators in 25 States (16 east of the Great Plains) about 128,000 pounds of untreated steam-crushed oats and slightly more than 351,000 pounds of oat baits prepared for controlling prairie dogs, ground squirrels, field mice, and other rodents. During the last few years this mixing station has grown into a national service organization in rodent control.

TEN-YEAR CONTROL PROGRAM APPROVED

The success in pest-control service thus far attained with limited resources has indicated that even greater efficiency might be expected under a definite control program over a long period. Congress has given this matter consideration and, as a proviso to the act making appropriations for the department for the fiscal year 1929, called for an investigation of the feasibility of such a program. The investigation was made and a report thereon recommending a cooperative program to cover a 10-year period was submitted to the Seventieth Congress.

Bills were introduced in both Houses of the Seventy-first Congress to authorize the institution of the 10-year plan of control. The proposal was approved by the Bureau of the Budget, and hearings were held by the Senate Committee on Agriculture and Forestry and the House Committee on Agriculture. Strong indorsement of the measure was given by many National, State, and local organizations. These included State legislatures; State agricultural commissions; farm bureau federations; cattle, sheep, goat, and poultry raisers' associations; horticultural societies; sportsmen's associations; State fish, game, and conservation departments; and chambers of commerce. Objection was presented by naturalists and others, individually and through their organizations, who feared general extermination of certain animals and opposed some of the control methods employed. The bill as passed by Congress, and approved by the President on March 2, 1931, authorizes appropriations not to exceed $1,000,000 annually. The passage of this law after careful consideration and public hearings, at which ample opportunity was given for both the proponents and the opponents of the measure to express their views, should set at rest any reasonable doubt as to whether the control program deserves public approval.

The 10-year program contemplates cooperation between Federal, State, and local agencies. With a view to avoiding duplication of work and insuring the best results from efforts and funds expended, the Bureau of Biological Survey will continue its cooperation with the Forest Service, the Indian Service, and the Office of Cooperative Extension Work; with extension service organizations, including colleges and county agricultural agents; and with State departments of agriculture, game commissions, county commissioners, and various agricultural, horticultural, and livestock organizations.

A POLICY OF CONTROL, NOT EXTERMINATION

It can not be too strongly emphasized that the established policy of the Biological Survey with regard to injurious species of wild animals has been and will continue to be one of control rather than of extermination.

The Bureau of Biological Survey, that branch of the Federal Government primarily concerned with wild-life conservation, takes the position that it is well for the conservation of the wild life of the country that leadership in the control of injurious species has been delegated to an organization concerned with the welfare of the various forms, charged with the enforcement of wild-life conservation laws and the administration of wild-life refuges, and recognizing the desirability of preserving representatives of all forms of wild life on suitable areas.

It is only by control measures properly directed, however, that the burdensome losses suffered by farmers and stock raisers can be reduced and the beneficial and interesting forms of wild life protected from their natural enemies when these become overabundant. Though measures in line with this policy may mean local extirpation of harmful forms in some cases, it will not result in the eradication of any species.

STUDIES OF EFFECTS OF PREDATOR CONTROL ON FUR ANIMALS

Based upon the supposition that operations for the control of predatory animals are seriously destructive to forms of wild life other than those on the control program, criticism has been voiced by certain zoological organizations, fur trappers, and others who have expressed the fear that large numbers of smaller fur-bearing animals are being destroyed through the exposure of poisoned baits meant for coyotes and wolves, and have charged that field workers engaged in the control activities of the Biological Survey are irresponsible. In order that the facts in these cases might be fully known and the bureau's program and practices fully understood, the Bureau of Biological Survey proposed that a joint investigation be made by the bureau and the American Society of Mammalogists. Such an investigation was carried out during the year by nine naturalists—five employees of the Bureau of Biological Survey and four members of the society not connected with the bureau.

The substance of the majority of the reports of these investigators was that the bureau's employees are responsible men; that the investigators found little evidence that true fur bearers are being killed in any considerable numbers; and that in general, poison was found to

have been so placed as not seriously to endanger the smaller fur-bearing animals. The bureau's program of predatory-animal control was discussed at a conference of its field leaders held at Denver, Colo., which was also attended by leading representatives of the raw-fur industry. As a result, former misunderstandings of the bureau's policies and methods of operation were cleared up and plans developed for cooperation between the bureau and the raw-fur industry. The representatives of this industry expressed confidence in the program and practices of the Biological Survey and offered to work toward the enactment of State laws to prevent the indiscriminate use of poison in taking wild animals, by requiring that it be employed only under the supervision of the Bureau of Biological Survey or of responsible agencies of the State governments.

RESEARCH IN CONTROL METHODS

An important feature of the bureau's part in cooperative control work is a laboratory at Denver, Colo., where research is undertaken for improvement in field methods. Results of work at this laboratory have enabled the Biological Survey to adopt and to recommend to its cooperators improved methods, with a direct saving in cost, an increase in efficiency, and greater safety in operations.

Pharmacologists and other research workers connected with the laboratory have during the year continued investigations in methods of controlling predatory animals and rodents. They have devised improved methods for the control of coyotes and wolves whereby the quantity of poison used can be materially reduced by placing poison stations in fewer but better locations and by reducing the number of baits around each station and the quantity of processed strychnine in each bait.

Investigations were continued in California on the efficacy of thallium-treated grains in rodent-control operations and to note whether these poisons are unduly destructive to other forms of wild life. Technical Bulletin No. 238, the Pharmacology of Thallium and Its Use in Rodent Control, published during the year, discusses in considerable detail the action of the poison and the preparation of the baits. The conclusion reached is that thallium as a rodent poison should not be recommended to the public, but that where its use is necessary for the control of highly resistant species of rodents, it should be entrusted only to those persons who understand its dangerous qualities and will exercise appropriate care in using it.

CONTROL OF PREDATORY ANIMALS

Predatory-animal control operations were conducted during the year in most of the States west of the Mississippi River, in Wisconsin and Michigan, and in parts of Tennessee. Because of lack of funds, little work was done in Nebraska and Kansas and none in North Dakota, Iowa, Missouri, or Louisiana, though calls for assistance came from all these States, as they did from Illinois, Indiana, Mississippi, West Virginia, and New Hampshire in the East. Within the borders of the latter States there are still breeding areas of such predators as bobcats, coyotes, and wolves, and farmers and stockmen suffer from their depredations in parts of those States. A hunter was assigned to special work in Tennessee for three months, and demon-

strations in trapping predators were given on the Pisgah National Forest and Game Preserve in North Carolina.

Control of wolves and coyotes in Alaska, which has been handled largely as an educational campaign among trappers, was continued with a small force of hunters. Definite instructions have been prepared for distribution among private trappers and steps are being taken to make effective scent materials available for their use.

During 1929 more game animals were killed on the national forests by predators than by hunters, according to information received from the Forest Service. The reports indicate that more than 88,000 deer, elk, moose, mountain sheep, antelope, and mountain goats were victims of predatory animals, while fewer than 60,000, including 3,452 bears, were taken by hunters. These estimates explain in part why many sportsmen favor predatory-animal control.

During the past year there has been a definite reduction in the quantity of poison used in predatory-animal control, and a still further reduction is planned for future operations. This is made possible because in many localities where poisoning efforts have been concentrated in the past, predatory animals have been reduced in numbers until satisfactory control can now be continued through the use of traps. Livestock organizations and individuals who formerly used large quantities of poison for protecting their flocks and herds have been increasingly cooperating with the Bureau of Biological Survey and are definitely placing with the bureau the supervision of the use of poison. As a result there have been a gradual tightening up on the distribution of poison and a decrease in the quantity used in the cooperative work.

COYOTES AND WOLVES

Coyotes continue to present the most serious problem in predatory-animal control. These animals infest all the western portion of the United States, and sporadic infestations have developed in the past few years in several States in the East, including northern New York and Tennessee, where farmers report rather serious losses. Coyotes have also been recently reported in Haversham County, Ga., and in the vicinity of Jamieson, Fla., and one was killed on the outskirts of the city of Baltimore, Md., during the year. Throughout Alaska coyotes continue to extend their range, and reports received during the past year indicate that some have now reached as far north as Point Barrow.

In spite of the predatory-animal control work that has been done, largely in the Western States, much still remains to be done before the losses of livestock, poultry, and game can be reduced to a reasonable minimum. Several instances have been noted during the past year illustrating how predatory animals may concentrate in sections where they are not molested and food is plentiful. One Biological Survey hunter working in the State of Washington took 176 coyotes, largely young from the dens, during the month of April in the Horse Heaven and White Bluffs-Hanford section; 22 wolves were taken during the year in an area less than 10 miles square in Creek County, Okla.; and 50 coyotes were taken from an area of approximately half a township in Nebraska, which includes a portion of the Niobrara Game Reservation maintained by the Biological Survey.

Coyotes easily adapt themselves to settlement and in many places obtain a large portion of their sustenance from the poultry and domestic stock of farmers and ranchers. A half-grown coyote pup was caught killing chickens in a poultry yard in the center of the city of Cheyenne, Wyo., and a pair of coyotes killed a registered ewe within 100 yards of a residence on a ranch near that city. In another instance where a wire inclosure was erected for protection from predators, a coyote killed 30 turkeys, which were frightened by its jumping against the fence until they flew over the top and became easy prey.

The secretary of the Ardmore (Okla.) Chamber of Commerce writes that as a result of the bureau's wolf-control work in the State, the farmers living in an isolated valley in Carter County were able to raise poultry that was sold during November and December for $10,000. Ten years ago this community marketed both hogs and poultry in great quantities, but the increase in wolves since that time made it impossible to raise them profitably until after control operations had been undertaken.

In Texas wool growers attempted to prevent damage to their flocks by erecting wolf-proof woven-wire fences, but such inclosures, though built at great expense, are not entirely effective in preventing depredations. In one instance hunters working within so-called wolf-proof pastures, heavily stocked with sheep and goats, took 9 bobcats and 30 coyotes in one month.

More coyotes were taken this year than last, the greater portion on large ranges and in farming sections, where there is little danger to fur-bearing animals.

The first edition of 15,000 copies of Leaflet No. 59, Hints on Wolf and Coyote Trapping, published in 1930, was exhausted during the year, and it was necessary to make a reprint. A mimeographed pamphlet (Bi–1152), Suggestions on Trapping Coyotes and Wolves in Alaska, has been prepared for multigraphing for the use of private trappers in the Territory.

MOUNTAIN LIONS

Operations for the control of mountain lions on stock and game ranges were undertaken with State cooperation in parts of Oregon, New Mexico, Arizona, Colorado, Montana, Washington, Utah, Texas, Idaho, Nevada, and California. These animals were hunted principally with trained dogs, but a number were taken in traps. In certain areas where there was a surplus of such game animals as deer and elk, and where mountain lions were numerous but did no serious damage to domestic stock, little effort was made toward their control, which was not deemed justified in such localities. Where game animals are scarce, however, mountain-lion control may become a vital factor in building up the stocks. One hunter, working in a very small area of the Olympic Mountains of Washington, discovered carcasses of 8 deer and 7 elk killed by mountain lions and 3 deer killed by bobcats.

Through the Pan-American Union, at Washington, D. C., information requested was forwarded to officials in Argentina regarding methods followed for the control of mountain lions. It was reported that these animals are destroying large numbers of cattle and horses in that country, and that efforts to control them have been fruitless.

A leaflet detailing methods of setting traps and preparing scent lures for mountain lions is now in the course of preparation.

A 1-reel film, The Cougar Hunt, released in January by the department's Office of Motion Pictures, has been very popular. Taken in southern Utah, it portrays the losses caused by mountain lions and shows the methods of control used by the bureau. It has not only been shown extensively on the screen but was chosen as the first department film to be used in a television broadcast, over radio station W3XK. A mountain-lion hunt was also chosen as the subject of a news feature by a nation-wide news-reel corporation and had a wide showing over the United States. This picture was taken in Arizona through the cooperation of the bureau's leader of predatory-animal control.

BOBCATS AND LYNXES

Requests for assistance in the control of bobcats in the Eastern States continue to be received, and a special demonstration of effective methods of trapping bobcats was made at Asheville, N. C., for the protection of game birds and young deer.

Leaflet No. 78, Hints on Bobcat Trapping, was issued during the year to supply up-to-date information for use in correspondence and for distribution where demonstrations are impracticable.

CONTROL OF INJURIOUS RODENTS

Enormous annual damage to farm crops and forage in the United States is suffered through the depredations of prairie dogs, ground squirrels, pocket gophers, jack rabbits, porcupines, rats, field and house mice, and other injurious rodents. In addition to the losses they cause in crops and forage, these rodents also directly cause destructive soil erosion by denuding large areas of vegetative cover. Local control of these pests is necessary throughout the United States, and the problem is so far-reaching as to require close cooperation of individuals, organizations, counties, States, and the Federal Government.

Much of the damage by injurious rodents occurs in the West; and, like the predators, when abundant on Federal lands the rodents become a menace to adjacent farms and ranches. Responsibility for their control on public lands rests largely with this bureau. According to a recent survey made by the Forest Service 15,570,704 acres of national-forest lands are infested with range-destroying rodents. On adjoining private lands, even though the owners may spend large sums to rid their own holdings of rodent pests, reinfestation from the public domain usually occurs. In addition to rodent-control operations on public lands the bureau furnishes expert advice to thousands of farmers and ranches and provides leadership in cooperative work on private lands. The funds provided this year through congressional appropriations for emergency employment were helpful in carrying on additional work on many areas of public lands that heretofore have had to be neglected. With the provision of the additional funds contemplated under the 10-year control program, the bureau will be in position to respond to more of the re-

quests for service in clearing public domain and in supplying additional supervision and leadership in campaigns financed by landowners.

Organized control operations were carried on during the year under the leadership of the Biological Survey in 30 States, and educational work in 5 others. These operations were largely conducted in the West though much work was done east of the Mississippi River, and it is planned to cooperate more fully in this section when resources permit.

The abnormal drought conditions of the past year afforded excellent opportunity for effective work in rodent control, many rodents being forced to migrate from dry-range areas to crop-growing sections, where succulent food was more readily obtainable. This in many cases led to unusual concentrations and simplified control. Unfortunately, however, in many sections landowners were not financially able to take advantage of this condition and could not carry on extensive operations.

GROUND SQUIRRELS

Cooperative ground-squirrel control was carried on in all States west of the Great Plains and in the Dakotas. In many of these States definite units of land have been set aside as control districts, and their systematic treatment each year has reduced rodent infestation to a point where the damage to crops and irrigation ditches is negligible. After one or two seasons of systematic poisoning within these districts, it has been possible to prevent further losses by patrol work about the borders, thus preventing reinfestation from public lands and from adjoining areas that are of too little value to warrant control operations. In many such districts where the original poisoning cost was from 7 to 10 cents an acre, the ground squirrels have been so reduced that control can be continued at an annual expenditure for patrol work of 1 cent an acre, a figure that landowners consider cheap insurance against damage by ground squirrels.

In extensive ground-squirrel control operations in California, difficulty has been experienced because the rodents refused to take strychnine-coated grains. As a result, local agencies have employed thallium baits on a large scale. During the past year charges were made that the use of thallium-treated grains was causing undue destruction of bird life; and many persons, ignorant of the Biological Survey policy of using thallium sparingly and only under close supervision, have criticised the bureau for its extensive use in that State. The Biological Survey crews working on Federal lands, however, have used only a very small quantity of thallium, and the bureau leader in California, acting in an advisory capacity to the State and county organizations in rodent control, has advised the county agricultural commissioners and others that thallium should be used only under responsible supervision of trained leaders. Emphasis has been placed on the fact that thallium-treated grains should never be distributed to private individuals and that it should never be used where strychnine-coated grains would bring satisfactory results. Recent investigations indicate that the destruction of birds is negligible where thallium is used properly.

PRAIRIE DOGS

Prairie dogs were formerly abundant on the Great Plains and westward to the foothills of the Rocky Mountains as well as in parts of Utah, New Mexico, Colorado, and Arizona. They lived in large colonies or towns, usually occupying excellent grazing locations. The settlement of the West has necessitated their local extermination over thousands of acres. Operations in eliminating them from valuable farm and grazing sections have been continued during the past several years, but much remains to be done.

RABBITS

Jack rabbits, because of a heavy toll from disease, have not been so serious a pest as formerly over most of the Western States. Moreover, a profitable market for the pelts was established during 1926 and 1927, contributing greatly towards the decrease of the animals. Operations were conducted during the year in several States for their local control where they were seriously destructive to crops and forage.

Both cottontail and snowshoe rabbits are destructive also in parts of the East. Plantings of spruce and pine timber in cut-over areas in northern Wisconsin are being seriously damaged. A large paper company in this section, which plans eventually to reforest 14,000 acres and thus far has planted about 800 acres, estimates that approximately 25 per cent of the plantings were injured last year by snowshoe rabbits.

POCKET GOPHERS

Pocket gophers are distributed throughout a large part of the United States, and there is a widespread interest in devising satisfactory methods for their control. They not only eat large quantities of growing grain but also cover much more with soil, and their mounds interfere seriously with the use of mowing machinery in fields and meadows. In irrigation ditches and canal banks their burrows often result in costly breaks and wastage of water, and thus seriously interfere with water distribution. In many mountain areas pocket gophers are especially destructive through causing erosion. In other situations they often kill growing trees by girdling them or gnawing off the roots. A cooperator in Texas reported that of 70 pecan trees set out in the fall and winter of 1929 about half were killed by pocket gophers the first year and the remainder during the second.

Officials of the Elephant-Butte irrigation district in Mesilla Valley, N. Mex., allotted $4,000 for pocket-gopher-control work during the past year. Irrigation companies operating in some parts of Idaho report that they are spending approximately 10 per cent of their operating funds for controlling pocket gophers on the ditch right of ways and adjacent areas. These expenditures indicate forcibly the interest of landowners in the control of this pest. The bureau's leaders have given material assistance in demonstrating methods of control and in assisting cooperators to reduce the numbers of pocket gophers. They have been called upon also to assist in the control of pocket gophers at airports, where the mounds raised

by these rodents have proved a serious hazard to take-offs and landings. At Minneola, Tex., officials in charge of the aviation field state that one plane wreck was due entirely to the work of pocket gophers.

PORCUPINES

In many sections of the United States porcupines have raised economic problems by seriously menacing growing timber and reforestation projects. The bureau has received authentic reports showing that porcupines are damaging large stands of yellow pine in the Umatilla National Forest, in the State of Washington, their work in some of the open draws ruining the timber value of more than 70 per cent of the trees. Lodgepole pine, Douglas fir, and mountain larch are also being barked by these rodents, and orchardists in the region reported numerous fruit trees damaged. Control measures instituted by field workers of the Bureau of Biological Survey, in cooperation with forces of the Forest Service, have effected considerable relief in this section. The condition found in the Umatilla Forest is typical of that in many other areas where porcupines are abundant.

BROWN RATS

Brown rats are a constant menace to human health and sanitation and to stored grains, food products, and other supplies. They have been known to cause serious fires by gnawing the insulating material from electric-light wires. Rat control has been undertaken in practically every State where the bureau has a control representative, bureau field leaders assisting in organizing and conducting demonstrations and cooperative control work in numerous antirat campaigns.

Outstanding rat-control campaigns were carried out during the year in the New England States in close cooperation with the State agricultural colleges. In New Hampshire, a state-wide 1-day drive against rats was organized. Bait material aggregating more than 6,000 pounds, or enough for half a million individual rat baits, was distributed throughout the entire State in a single afternoon. Each farmer received three different kinds of freshly prepared bait—raw meat, fish, and cereal—mixed with red squill and packed in half-pound, waterproof cartons. Other similar campaigns have been scheduled in Rhode Island, Massachusetts, and Connecticut.

Satisfactory progress has been made in developing a standardized rat bait in convenient packages, one that can be sold to cooperators at low cost. Such a bait will greatly simplify the organization of antirat campaigns, and permit more efficient work along this line.

Leaflet No. 65, Red Squill Powder in Rat Control, was issued in January, and Farmers' Bulletin No. 1638, Rat Proofing Buildings and Premises, was issued in December, in cooperation with the Division of Agricultural Engineering of the department.

FIELD AND HOUSE MICE

House mice are destructive to property in all parts of the United States, and field mice, widely distributed, sometimes increase in sufficient numbers to become a serious menace to agricultural activities.

The occasional outbreaks of field mice are not difficult to control by early organized measures. The bureau's bait-mixing station at McCammon, Idaho, shipped more than 46,000 pounds of prepared mouse bait during the year, largely to States east of the Mississippi River, for the control of meadow mice and pine mice. This assistance was of great benefit to farmers and orchardists who have been suffering from depredations of these pests.

SOIL EROSION CAUSED BY RODENTS

On thousands of acres of valuable western range land prairie dogs become a direct contributing cause of destructive soil erosion by removing the grass cover and even digging out the roots. Perhaps the worst rodent pests in this respect are the pocket gophers, which are found in great numbers in all the Western States and in some abundance in other sections. In summer the dirt removed by their burrowing activities is piled in mounds on the surface, and in winter such dirt is pushed out in the form of chainlike ridges under the snow. With the melting of the snow these miniature dikes aid in starting definite erosion scars. When sheep and cattle enter the mountain ranges, they break through into the shallow subsurface runways of the pocket gophers and thus make incipient gullies to carry off the water from both rainfall and melting snow.

In irrigation districts many breaks in ditches and reservoir dikes are directly traceable to burrowing by ground squirrels, pocket gophers, or prairie dogs. A heavy head of water escaping through a small hole in the bank of an irrigation ditch soon cuts great gullies. Adequate control of injurious rodents can therefore materially decrease soil erosion. A fuller discussion of the rôle of burrowing rodents in starting destructive erosion was published in the Yearbook of Agriculture for 1931 (pp. 481–484).

CONTROL OF ANIMAL-BORNE DISEASES OF MAN

Several predatory animals and rodents are carriers of diseases that seriously menace human health. In some instances these animals transmit diseases directly, by bite or by other contact, while in others they act as hosts for the insects that carry the disease from the animals to man or (as in the case of rats) contaminate human food.

Among these animal-borne diseases are rabies, carried by coyotes; tularemia, by wild rabbits, ground squirrels, and coyotes; bubonic plague, by rats and ground squirrels; and Brill's disease, by rats.

Prompt and effective measures for the control of predators and rodents in affected areas are thus essential for the protection not only of livestock and other farm and range products but in some cases of human life itself.

RABIES

The most dreaded of the diseases carried by wild animals is rabies, or hydrophobia. Domestic dogs are the usual source of infection, but many cases on record demonstrate that the disease is transmitted to coyotes and thus is spread over a much wider area than would have been the case with dogs alone.

Sporadic outbreaks of rabies occurred in Washington and in Nevada, and several unverified reports of occasional losses of cattle by rabies in the southern part of Oregon were received. On the whole, however, this disease has not caused much concern in recent years. Little difficulty was experienced with it in California; and when an outbreak of serious proportions was reported in five counties of Texas, the bureau's leader of predatory-animal control for that State immediately transferred three additional coyote hunters to that section, and this resulted in effective control of the situation.

BUBONIC PLAGUE

Interest in the control of ground squirrels in California continues because they are carriers of bubonic plague. Federal officials are cooperating with county and State organizations in their efforts to reduce the ground-squirrel population in infested areas of southern California.

BRILL'S DISEASE

In Texas, the State health officer in Austin County requested the assistance of the Bureau of Biological Survey in organizing an anti-rat campaign at Belleville, where 10 persons were ill with Brill's disease, which is a mild form of typhoid fever. This request was made following an outbreak of the disease, of which rats are suspected to be carriers. A cooperative rat campaign was inaugurated in an effort to check the spread of the epidemic.

ACQUISITION OF LANDS FOR BIRD REFUGES

MIGRATORY BIRD CONSERVATION ACT

At the time of the passage of the migratory bird conservation act of February 18, 1929, authorizing a Federal bird-refuge program, most of the areas that served as sanctuaries for wild fowl were situated in the West and, with the exception of the Bear River Migratory Bird Refuge, Utah, had been created out of relatively small areas of public domain or within reclamation projects on suitable bodies of water. In establishing these refuges there was small latitude in choice of lands, and funds were not available for the Federal Government to acquire suitable privately owned tracts, either adjacent to existing refuges or elsewhere.

The migratory bird conservation act remedied this condition by authorizing the appropriation of funds with which to conduct investigations in other places and to acquire refuge lands where needed. The appropriation of $75,000 for the fiscal year 1930 made the first field investigations possible. For the fiscal year 1931 $200,000 was made available for the further prosecution of the investigations and for the acquisition of areas approved for purchase by the Migratory Bird Conservation Commission. Wild-fowl food resources have been studied on one or more areas in every State in the Union; land examinations have been made; studies of soil cover, soil-productive value, and related economic studies have been undertaken; and the status of ownership has been determined within 115 desirable units embracing 3,021,158 acres.

STATE ENABLING ACTS

At the close of the fiscal year, 40 States had passed acts enabling the Federal Government to acquire refuge lands within their borders, under the Federal law a prerequisite to the establishment of refuges. Of the 17 States listed in last year's report as not having taken such action, the following 9 have now passed the necessary legislation:

Alabama.	Massachusetts.	Oregon.
Delaware.	New Jersey.	Texas.
Indiana.	North Dakota.	Wisconsin.

The eight States that have not yet acted to authorize the acquisition of migratory-bird-refuge lands by the Federal Government are:

Arkansas.	Pennsylvania.	Vermont.
Idaho.	Tennessee.	Washington.
New Hampshire.	Utah.	

PURCHASES AND LEASES OF LANDS FOR MIGRATORY-BIRD REFUGES

The Migratory Bird Conservation Commission, at its first meeting, held in May, 1930, to consider recommendations made by this department, approved the purchase or lease of 37,735 acres in two units, one in Colorado and one in South Carolina. At a later meeting on December 18, 1930, the commission approved the program presented, recommending the purchase or lease of 73,782 acres in four units—in Florida, California, North Carolina, and Nebraska.

The first two migratory-bird refuge areas approved for purchase or lease embraced nearly 5,200 acres in Alamosa County, Colo., for the San Luis Lake Refuge; and approximately 32,500 acres for the Cape Romain Refuge, in Charleston County, S. C. Both of these were described in last year's annual report. The four new acquisitions approved by the commission were the St. Marks Refuge, Florida; the Salton Sea Refuge, California; the Swanquarter Refuge, North Carolina; and the Crescent Lake Refuge in Nebraska. On all these migratory-bird refuges all forms of wild life are protected by law.

The purchases for the Salton Sea Refuge will add nearly 9,000 acres to the 15,733 in public lands set aside by Executive order of November 25, 1930, thus making a wild-life refuge of 24,715 acres. The privately owned lands were intermingled with the reserved tracts of public domain. The area, situated at the southern extremity of the Salton Sea and supplied with fresh water flowing from the Imperial Valley irrigation district, is an important concentration point for the ducks and geese that traverse the Pacific coast "flyways" in their migrations.

The Crescent Lake Migratory Bird Refuge, in Garden County, western Nebraska, will embrace 39,000 acres, selected for purchase and lease from a total of more than 200,000 acres examined in this famous wild-fowl nesting region, and chosen because of its preeminent value as a breeding, resting, and feeding ground for the many species of ducks and shore birds that use the Great Plains "flyways."

The Gulf coast in northwest Florida is a favorite winter resting ground for ducks, geese, and shore birds, but up to the time of the bureau's recommendation for the purchase of 13,982 acres for the creation of the St. Marks Refuge in Jefferson, Taylor, and Wakulla

Counties, no bird sanctuaries existed there. The new refuge will extend about 12 miles along Apalachee Bay.

The eastern seaboard of the United States has been woefully lacking in migratory-bird refuges, there having been only one refuge area (some 2,500 acres, situated on the Savannah River, in South Carolina) established for migrant waterfowl prior to the adoption of the program of acquisition of lands for these birds. The Cape Romain Refuge was approved for purchase last year and the Swanquarter Refuge, in Hyde County, N. C., an area of approximately 11,800 acres, this year. This new refuge is not only an important concentration point for the ducks and geese that frequent the Atlantic coast "flyways," but, as the name implies, is a favorite resort for swans. With the intermingled waters of Pamlico Sound, the refuge will make an administrative unit of about 20,000 acres.

The area of the 6 refuges thus far approved by the Migratory Bird Conservation Commission for purchase or lease by the bureau aggregates 111,517 acres, 3 refuges on the eastern seaboard, 1 in Colorado, 1 in Nebraska, and 1 in southern California.

The plans as developed contemplate a nation-wide network of refuges, each containing from 20,000 to 50,000 acres, possibly one or more in every State of the Union. By reason of the peculiar conditions in certain localities it may not in every case be feasible to acquire as much as the desirable minimum in one unit, but smaller refuges will be the exception rather than the rule. Negotiations are continuing for the acquisition of lands in those areas that have not been fully rounded out, so as to form complete administrative units.

RESERVATIONS OF PUBLIC DOMAIN FOR MIGRATORY-BIRD REFUGES

In addition to the areas obtainable by purchase or lease, the Biological Survey, after examination, has selected several areas of public domain that will be useful for refuge purposes. During the year the Fallon Migratory Bird Refuge, in western Nevada, was established by Executive order, and will later be enlarged and rounded out through the acquisition of privately owned lands. The Salton Sea Refuge in southern California, as already stated, was created in the same manner. The refuges noted in last year's report were similarly set aside: Benton Lake in Montana and Salt Plains in Oklahoma.

IMPORTANCE OF THE REFUGE PROGRAM

In helping to meet unusual conditions, the Federal acquisition of refuge lands is to-day serving the States and the whole country in a twofold manner: (1) Through the establishment of sanctuaries, natural environment essential to the welfare of waterfowl will be preserved and improved, particularly in areas where long droughts have seriously reduced the once large numbers of these birds. (2) Acquisition of lands, in many cases of low productive value, will mean the distribution of money to landowners who otherwise would have little opportunity for sale, and this has already been in some degree a factor in relieving unfavorable economic conditions.

Many of the areas being acquired will not only be highly valuable as refuges for migratory birds but will also contribute through administrative control to the production of fur, principally muskrat, and in some areas to the protection of other native mammals.

An explanation of the migratory-bird refuge program, entitled, "Refuges being created for the protection of migratory birds," was published in the Yearbook of Agriculture for 1931 (p. 456–459). Further information on the subject was presented in the first annual report to Congress (fiscal year 1930) of the Migratory Bird Conservation Commission, of which the Secretary of Agriculture is chairman (H. Doc. No. 670, 71st Cong., 3d sess.).

UPPER MISSISSIPPI REFUGE LANDS

The acquisition of lands for the Upper Mississippi River Wild Life and Fish Refuge, established under act of June 7, 1914, continues at a satisfactory rate. Practically all lands that can readily be acquired have been taken under contract; the remaining area of approximately 15,000 acres may have to be obtained through condemnation. The total area of land and water under the jurisdiction of the Biological Survey within the exterior limits of the refuge is 129,149 acres, made up of 112,295 acres of land and approximately 16,844 acres of water area in sloughs, lakes, and ponds, not surveyed or paid for, but completely controlled by reason of ownership of the shores. It is estimated that the channel of the Mississippi River contains about 70,000 acres within the refuge, but this is not included in the total acreage. The net increase in the area under control over that for the preceding year is 6,303 acres.

The average cost of land acquired and in process of acquisition has been $6.32 an acre. The average cost per acre for lands taken under the provisions of the act, which authorizes a maximum average of $10, has been $8.10.

BEAR RIVER MIGRATORY BIRD REFUGE ADDITIONS

The acquisition of lands for the Bear River Migratory Bird Refuge, Utah, as authorized by act of April 23, 1928, has been completed except for the consummation of three land-exchange cases. Upon the completion of the exchange transactions as now agreed upon the net area under control within the refuge will be 53,566 acres.

CHEYENNE BOTTOMS MIGRATORY BIRD REFUGE LANDS

Progress continues to be made on the Cheyenne Bottoms Migratory Bird Refuge, situated in Barton County, Kans., acquisition of which was approved by act of June 12, 1930, though titles have been found to be unusually complicated by reason of oil leases and speculation. Engineering investigations have been completed here, and title examination of the many tracts within the unit is being conducted. Negotiations have advanced to the point where practically all landowners have been interviewed.

MAINTENANCE OF BIRD REFUGES AND GAME PRESERVES

Wild-life reservations under the jurisdiction of the Biological Survey on June 30 numbered 92, chiefly in continental United States, but scattered also in Alaska, Hawaii, and Porto Rico. All are bird refuges except one established as a muskrat and beaver preserve in

Alaska, and under the Alaska game law game birds also are protected there. The number includes 6 established primarily for big-game animals (including 1 winter elk refuge), an island reservation in Alaska for experiments in the propagation and crossing of reindeer and caribou, and numerous others, some for wild life in general but 83 specifically for birds. Six new refuges were established during the year, 1 for mammals and birds and 5 chiefly for migratory game birds.

To meet the demand for information on reservations for wild life administered by the several States, a list has been revised and reissued as a mimeographed pamphlet (Bi–652). The cooperation of State game authorities was enlisted in its preparation and in supplying information concerning the areas, their locations, and the forms of wild life protected on them.

An official circular containing the regulations adopted by the Secretary of Agriculture under date of May 7, 1930, for the administration of Federal wild-life refuges under the jurisdiction of the Biological Survey, together with extracts of pertinent legislation, was issued during the year (S. R. A.—B. S. 73).

The special funds made available this year by Congress for the relief of unemployment also served the purpose of greatly advancing the Federal wild-life refuge program, particularly on the big-game preserves, through the construction of buildings, fences, fire-protective and water systems, the surveying and posting of reservations, and other improvements. Wherever available, local mechanics and laborers were used, particularly men with families dependent upon them, and standard wages were paid. About 80 per cent of the program was completed by the end of the year, the remaining 20 per cent having been let under contracts to be completed during the fiscal year 1932.

REFUGES ESTABLISHED AND ENLARGED

The six wild-life refuges established during the year for administration by the Biological Survey, chiefly for the protection of migratory birds, are as follows: (1) Cape Romain Migratory Bird Refuge, S. C., established by lease of 32,555 acres on the coast, north of Charleston; (2) Salton Sea Migratory Bird Refuge, of 15,733 acres of public lands in the Imperial Valley, Calif., set aside by Executive order, and later to be increased by the purchase of approximately 9,000 acres; (3) Crescent Lake Migratory Bird Refuge, western Nebraska, established by lease of 39,038 acres and added to by the withdrawal by Executive order of 173 acres of public lands; (4) Charles Sheldon Wild Life Refuge, an area of approximately 30,700 acres of public lands in Washoe County, Nev., set aside by Executive order as a refuge for antelope and sage grouse; (5) St. Marks Migratory Bird Refuge in Jefferson, Taylor, and Wakulla Counties, Fla., on the Gulf coast, established by purchase; and (6) Fallon Migratory Bird Refuge, approximately 17,900 acres within the Truckee-Carson irrigation project, in Churchill County, Nev., established by Executive order. It is planned to place protectors on these refuges during the coming fiscal year.

The Nunivak Island Reservation in Alaska was enlarged by Executive order to include Triangle Island and all small unnamed islands and rocks lying adjacent to Nunivak.

BIG-GAME PRESERVES

Requests for buffalo and elk as nucleus herds for State preserves and for exhibition in city parks have been met from surplus stock on big-game preserves, through cooperative arrangements. The placing of surplus animals from the Federal preserves in State, city, and municipal care facilitates the necessary disposal of surplus stock, relieves the Federal Government from caring for increasing numbers of the various species, and gives wider opportunities for exhibition of the animals, thus increasing their educational value.

The numbers of big-game mammals on the four preserves maintained for them by the bureau and the increase in certain species are given in Tables 1 and 2.

TABLE 1.—*Animals on big-game preserves of the Bureau of Biological Survey, June 30, 1931*

Preserve	Buffalo	Elk	Antelope	Mountain sheep	Deer		Total
					White-tailed	Mule	
National Bison Range, Mont.	372	[1] 145	----	56	[1] 12	[1] 84	[1] 669
Wind Cave Game Preserve, S. Dak.	168	[1] 28	29	----	1	4	[1] 230
Niobrara Reservation, Nebr.	138	[1] 92	15	----	2	----	[1] 247
Sullys Hill Game Preserve, N. Dak.	14	25	15	----	5	----	59
Total	692	[1] 290	59	56	[1] 20	[1] 88	[1] 1,205

[1] Estimated.

TABLE 2.—*Young of buffalo, antelope, and mountain sheep born on reservations of the Bureau of Biological Survey during the calendar year 1930* [1]

Preserve	Buffalo	Antelope	Mountain sheep
National Bison Range, Mont.	56	----	3
Wind Cave Game Preserve, S. Dak.	39	3	----
Niobrara Reservation, Nebr.	19	6	----
Sullys Hill Game Preserve, N. Dak.	2	5	----
Total	116	14	3

[1] Figures omitted for young of elk and deer, as only estimates could be made.

NATIONAL BISON RANGE, MONTANA

Funds available this year under the unemployment relief program enabled the bureau to construct 1½ miles of fence to complete the division of the National Bison Range, Montana, into three pastures, for the betterment of forage production through rotation of grazing. Improvement is already evident as a result of the first division fence, constructed two years earlier; and establishment of the third pasture, together with the continued elimination of surplus animals, should solve the present grazing problems on this range.

Additional improvements under the relief funds at this refuge included the building and moving of houses and sheds and the installation of a modern fire-protective system, with a 20,000-gallon concrete reservoir, the water for which is pumped from Mission Creek, a never-failing stream that runs through the reservation. Under the new

arrangements the fire hazard at headquarters is reduced to a minimum. Other work for the welfare of the wild life on this range, made possible under the relief funds, included 3.3 miles of trail construction and repairs to facilitate patrol in heretofore inaccessible places near boundary fences.

The herds on the bison range are in good condition, and the increases were far in excess of the losses by removal. The prospects were for a much larger buffalo-calf crop than last year's, the total born up to June 30 being 65, of which 6 died; the number for the calendar year 1930 was 56. The bands of elk and mule deer also have shown steady increases, despite several shipments of adult animals from the range during the year. Though the flock of mountain sheep suffered heavy losses last year, chiefly from chronic bronchopneumonia, only three deaths of adult animals were reported this year.

Surplus big-game animals have been removed from the bison range as follows: Buffalo, 4, 3 of which were donated for exhibition purposes and 1 sold as meat; elk, 10, of which 9 were furnished for stocking and exhibition purposes, and 1 was sold for meat; mule deer, 28, of which 26 were shipped to a purchaser in California for stocking his private preserve, and 2 were furnished for exhibition purposes to a zoological park in Detroit, Mich.; in addition 1 mule deer, accidentally killed, was sold as meat.

ELK REFUGE, WYOMING

With one of the mildest winters ever known in the Jackson Hole country, comparatively few elk came to the elk refuge and to the feeding grounds of the region, the largest number at one time being 3,000. The snowfall was the lightest on record; not more than 8 inches lay on the refuge at any one time. No feeding of elk was necessary, and the animals in the vicinity of the refuge, as well as those that stayed back in the mountains, wintered in very good condition with exceptionally few losses.

The light snowfall, however, had the effect of reducing the water for irrigation this season to about a third of the normal supply, and the prospects are not bright for a hay crop of more than 40 per cent. The month of June also was extremely dry and threatened entire failure of the grain and forage crops on unirrigated land.

The hay crop of 1930 amounted to 1,372 tons. Refuge hay carried over from preceding winters amounts to 2,620 tons, which, together with left-over State-owned hay, makes a total of 3,360 tons already available for use during the coming winter. The State also has in reserve 130 tons of cottonseed cake in the storehouse constructed on the refuge by the State game commission.

The experimental studies in the feeding of elk have been continued in cooperation with the Bureau of Plant Industry, as also were experiments in forage production and the elimination of squirreltail grass, which has been a cause of disease among the elk. Regular appropriations and funds made available for emergency employment rendered possible extensive construction and repair work on fences, buildings, and roads, and the purchase of farming implements and other equipment. The construction included 160 movable panels

for fencing the hay stacks, a greatly needed facility that will prevent much loss. In addition, the refuge boundaries were surveyed, monumented, and posted, and a survey was made of a proposed water diversion.

WIND CAVE GAME PRESERVE, SOUTH DAKOTA

The extreme drought, which continued all through the winter and spring months, resulted in a serious shortage of water and lack of forage growth at the Wind Cave Game Preserve, South Dakota. The creek that runs through the preserve, however, furnishes an adequate supply of water for the game animals, and they have not suffered for lack of food. Sharp-tailed grouse are more plentiful than a year ago; and quail, which had not been seen or heard on this area since the summer of 1928, again nested in the vicinity of headquarters and were frequently heard. Predatory animals have been kept under control. Twenty-three buffalo were removed alive from the preserve during the fall and winter seasons, 12 of which were furnished under cooperative arrangement to the States of South Dakota and Nebraska for use in stocking State parks, 7 were sent to city parks for exhibition purposes, and 4 were sold for propagating purposes. One buffalo, accidentally killed, was sold as meat.

Under regular and emergency construction funds, much has been accomplished to improve conditions at this preserve.

During the travel year ended September 30, 1930, 23,649 visitors came to Wind Cave National Park, and probably at least that many visited the game area, since thousands of tourists pass by the game pasture but do not enter the cave.

NIOBRARA RESERVATION, NEBRASKA

The Niobrara Reservation, near Valentine, Nebr., is one of the most accessible of the wild-life reservations maintained by the Biological Survey and is of interest both as a big-game preserve and as a refuge for birds. Sharp-tailed grouse, prairie chickens, Hungarian partridges, ring-necked pheasants, and quail nest here, and with the improvement of water conditions in certain areas, plans for which are under way, the reservation can be made much more attractive to these species. The conditions for ground-nesting birds and other valuable wild life on the reservation have been improved through the destruction of predatory animals. The water areas are an attraction to large numbers of migrating wild ducks. State game officials are taking steps to supplement the protection that the western arm of the refuge affords to game birds by establishing a State preserve adjacent thereto.

The herds of buffalo, elk, and antelope have about reached the capacity of the present big-game pasture. This will be enlarged, however, by including an additional 1,600 acres. During the year, by use of the emergency employment funds, this area was inclosed with 5½ miles of 84-inch heavy woven-wire big-game fence. River crossings have yet to be provided before the new pasture can be used. Negotiations for the purchase of approximately 400 acres of privately owned land within the boundaries of the reservation have been satisfactorily concluded.

The construction work under the emergency and regular funds, including a new headquarters building, will greatly facilitate the administration of this refuge and will aid in the capture of animals to be disposed of for breeding and exhibition purposes. For lack of these facilities it has been necessary to butcher all such surplus animals on the range. Five buffalo and eight elk were removed from the reservation during the season 1930–31.

SULLYS HILL GAME PRESERVE, NORTH DAKOTA

By act of March 3, 1931, Sullys Hill was eliminated from the national park system and the area transferred from the Department of the Interior to the Department of Agriculture for exclusive administration by the Bureau of Biological Survey as a national game preserve. Adjacent lands uncovered by the recession of the waters of Devils Lake were added to the preserve, thereby adding 800 acres to the area which now includes about 1,600 acres. The act also authorizes further enlargement of the preserve by the acquisition of not more than 3,000 acres of land at an average price not to exceed $10 an acre.

The area considered for addition to the preserve contains considerable open grazing and hay lands, which would be particularly desirable for the welfare of the wild life under administration; and it also has some fine timber areas and small lakes and springs that would be of great importance to the preserve. The acquisition of the area would solve the problem of a satisfactory water supply.

Surplus big-game animals on this preserve were disposed of during the year as follows: Buffalo, 3, of which 2 were donated, for exhibition purposes to zoological parks; elk, 10, of which 8 were shipped to a State game preserve in Nebraska and 2 sold for meat; and white-tailed deer, 2, and antelope, 5, shipped to parks for exhibition purposes. In addition, 6 Canada geese were furnished the State game preserve at St. John, N. Dak. Three antelope died during the year, and 2 young deer and 1 young elk received injuries that necessitated killing them.

The Sullys Hill preserve is a popular resort, being favorably located on the Burtness Highway, and each year is visited by many tourists. The number for the past year aggregated 21,789, with 4,140 cars. Under the emergency employment funds, a field house and two rest rooms have been constructed to facilitate caring for the visitors attracted every year to the game preserve and Sweetwater Lake. This lake is a beautiful body of water 8 or 10 acres in area and is one of the most popular attractions at the Sullys Hill preserve. During long dry seasons, however, it seeps away through the shale rock bottom and bank at the western end, shrinking to about half its normal size. Engineering studies and tests have developed a thoroughly practical method of preventing the seepage by a system of interlocking steel piling. The emergency funds have made it possible to let a contract for the construction of three of the eight units of the system. Maintaining the level of fresh water in the lake will add greatly to its attractiveness and also render the water suitable for bathing and other recreational uses. Contracts were awarded also for digging a well and installing a water-distribution system.

BIRD REFUGES

BOUNDARY SURVEYS OF OLDER REFUGES

Through the provision of emergency employment funds, the Biological Survey was authorized to make surveys and to post the boundaries of refuges previously established, but not properly marked. Under this authority topographic surveys were made on the Big Lake Refuge in Arkansas, with the view of developing this place to the highest possible use. Boundaries also were surveyed and monumented on the Rio Grande Refuge, in New Mexico; the North Platte and Niobrara Refuges, in Nebraska; Chase Lake, Stump Lake, and Sullys Hill Refuges, in North Dakota; and the Belle Fourche Refuge, in South Dakota, and all these except North Platte and Niobrara were posted.

Much-needed posting and reposting of most of the Florida bird refuges also was accomplished near the end of the year. On some of the more important islands and keys in these refuges, in addition to the small metal shield signs, large board signs 5 by 6 feet in size were erected to apprise persons approaching by boat of the character of the areas.

Special regulations for the administration of the Aleutian Islands Reservation in Alaska were published under date of October 31, 1930, together with extracts from pertinent legislation (S. R. A.—B. S. 74).

HAWAIIAN ISLANDS BIRD RESERVATION

1931

In the summer of 1930, the protector of the Hawaiian Islands Bird Reservation, who is stationed at Honolulu, made an inspection trip to Laysan Island, the most important of the refuge group. During the 16 days he spent there he planted 60 trees of various species suited to the island, also beans and seeds of grass and vines. He reported that the rushes that give protection to the small birds on hot days had reappeared along the edges of the lagoon, and that dead twigs of tobacco, which had sprung up everywhere on the area, were being used by the gannets and frigate birds for nesting material. He found sooty terns the most plentiful species on the island and the wedge-tailed shearwater next in importance. The Laysan albatross, man-o'-war bird, red-footed booby, blue-faced booby, and noddy tern were among other species seen, and turnstones were there in great numbers and were observed eating the eggs of the noddies. The Laysan honeyeater is apparently extinct, as none was seen. One individual of the Laysan teal was seen—a female that was either injured or feigning injury, as she would not fly but fluttered about. Her nest was discovered, and the eggs were found to have been destroyed. No evidences of recent poaching were seen on Laysan.

ALEUTIAN ISLANDS RESERVATION

Amended regulations have been adopted, transferring the administration of the Aleutian Islands Reservation to the bureau's chief representative in Alaska, who by virtue of his position is executive officer of the Alaska Game Commission. This action is in accordance with the policy of more closely consolidating administration of Alaskan affairs under resident officials.

LAKE MALHEUR BIRD RESERVATION, OREG.

The extremely dry season in the region about the Lake Malheur Bird Reservation, Oreg., still further restricted the water area, and the birds nested on only a small section of the refuge. Local farmers, whose hay crops were a total failure, were permitted to sow grain over approximately 6,000 to 8,000 acres on the lake bed, in an endeavor to provide for their stock next winter. Few muskrats remain on the area.

The protector is in position to render assistance to the State game warden in his work and also assists in the control of predatory animals and birds in the locality. Seven miles of telephone line have been built, an improvement that has long been needed in patrolling the reservation.

The Attorney General at the request of this department instituted a suit in the United States Supreme Court against the State of Oregon to determine ownership of lands in the lake bed and vicinity. Congress included an item in the second deficiency appropriation act to meet the expenses of this action and the investigations necessary in the preparation of the case. The total scope of this project contemplates a survey of many hundred miles of property lines and the topographic survey of 85,000 acres. Field work was started in April, and at the close of the fiscal year 252 miles of boundary line had been surveyed and suitably marked, while 169 miles of level lines had been run. The development of the full facts as to land ownership will be helpful in determining water rights on the Blitzen River, from which Lake Malheur receives its supply, the allocation of which is being undertaken by the State water board. Establishment of an irrigation season and an assured water supply from the Blitzen River are vital to the continued welfare of the various species of wild life that frequent the Lake Malheur Reservation.

BIG LAKE BIRD RESERVATION, ARK.

The drought that prevailed at the Big Lake Bird Reservation, in northeastern Arkansas, in the summer of 1930 was not broken until December. For lack of water on the area, the birds passed by during their fall migration, but with the return of water in February, thousands of mallards and other ducks came to the refuge. Many other birds, such as gulls, cormorants, snipe, yellowlegs, sandpipers, killdeer, egrets, and herons, as well as many species of insectivorous birds, also have used this area as a resting and feeding ground. A large increase in most species of ducks has been recorded, but in the case of the wood duck, which nests on the refuge, there was a decrease in numbers, due, it is believed, to the drought of last summer, at which time the young birds were unable to reach water. It is estimated that about 25 per cent of last season's hatch on the reservation was lost.

On account of the drought, many local farmers who did not have feed for their stock were granted permission to harvest hay on the refuge, and about 1,000 tons were cut. This did no harm but saved many domestic animals from starvation. Grazing for their work stock was also afforded near-by residents. Under emergency employment funds a contract has been awarded for the excavation of a

ditch 3½ miles long, 16 feet wide, and 5 feet deep, for the introduction of water to the refuge during low stages. The work should result in great benefit to the refuge during such dry seasons as have prevailed during the last few years.

The present outlook indicates an abundance of feed for the birds during the coming year. Few violations of the law protecting the reservation have been reported.

BEAR RIVER MIGRATORY BIRD REFUGE, UTAH

The work of constructing the outer embankments and the division dikes on the Bear River Migratory Bird Refuge, Utah, has progressed rapidly this year, being favored by comparatively low stages of water. While there was an excess of water during the early part of the spring, later in the season, as a result of the light snowfall in the mountains, Bear River reached the lowest stage recorded for several years.

On the first two units of this refuge the contractor completed his work late in June and the contractor for the other three units has made rapid progress and was scheduled to complete construction work on the outer and division dikes not later than August 1, 1931.

Construction work already completed has in general withstood the hazards to which it has been subjected by the varying temperatures and severe storms of the region. The only damage has been to one overflow box, in the first unit constructed, and here the consequent washing will necessitate extensive repairs.

Some experimental work has been conducted in planting and seeding the dikes to rushes, saltgrass, and other plants for protection against the action of ice, wind, and high waves, and the results have thus far proved satisfactory. In unit 1, which was completely flooded last August, several species of rushes and sago pondweed are growing in profusion, with good prospects for an abundant crop of these duck foods.

UPPER MISSISSIPPI RIVER WILD LIFE AND FISH REFUGE

Progress in rounding out refuge areas and intensifying administrative control has continued on the Upper Mississippi River Wild Life and Fish Refuge. Closed-area units are being enlarged wherever possible. An intensive survey made during the year produced information important in determining future administrative policies.

Plans for the 9-foot channel development in the upper reaches of the Mississippi River were advanced by the War Department during the year, and at one of the two public hearings on the subject, members of the Bureau of Biological Survey testified on the probable effect of the proposed dams on the wild-life and scenic values of the refuge. This subject was also given special attention by the Senate Committee on Wild Life Resources. Though there is some difference of opinion on the matter, the consensus seems to be that so far as game, fur-bearers, and fishes are concerned the project is likely to be beneficial, particularly if water levels are stabilized and steps are taken to lessen pollution. The first effects of raising the water levels, however, undoubtedly will be to destroy

much of the timber of the valley and to materially lessen the scenic value of the area for some years.

About the usual numbers of migratory birds stopped on the refuge during the fall, though there was possibly some decrease in spring, because of the extremely low water. There was, however, a marked scarcity of wood ducks and coots in the northern section of the refuge, both in the fall migration and the breeding season.

There was no trapping on the refuge during the spring of 1931, except where vendors of land had reserved trapping rights, and there the catch was negligible. Because of conditions unfavorable to fur animals, a close season on general trapping was maintained throughout the year. Under this protection the fur bearers have recovered so that normal abundance for the coming season is expected.

The policy of allowing the resources of the refuge to be utilized under special permits as freely as possible, without impairment to the refuge, has been continued. These privileges include using cabin sites, cutting brush for commercial purposes, removing fallen trees for firewood, harvesting hay, grazing livestock, and gathering medicinal herbs. Returns to the Government from these special permits aggregated $660.26 during the year.

Twenty-two fires occurred on the refuge during the year, burning an average area of approximately 475 acres for each fire. Both the number of fires and the area burned were unusually large, since many sloughs were entirely dry. A truck power pump and a fast motor boat have been added to the fire-fighting equipment of the refuge. The motor boat will make it possible to reach fires which break out where the highways can not be used. Plans for increasing the efficiency of the system for detecting fires have been perfected.

Little progress was made during the year toward control of the domestic and industrial sewage which enters the river in large quantities. This pollution is a serious matter within the refuge and unquestionably is having a most detrimental effect on fish. The State Board of Health of Wisconsin has pronounced the Mississippi River at La Crosse unsafe for bathing.

Reports concerning the effectiveness of the closed areas in affording protection to the birds are encouraging. Owing to the unsatisfactory results from experiments with the waterfowl colony on Lake Winona, the project was abandoned. Lack of control of the shore line presented the greatest difficulty in this undertaking and finally proved an unsurmountable obstacle.

The patrol service, though small, was instrumental in curbing law violations. Cordial cooperation between employees of the refuge and the State game departments has resulted in effective enforcement of both Federal and State laws throughout the area. Exterior boundaries of the refuge, especially along shore lines, have been marked by metal refuge shields mounted on metal posts.

ADMINISTRATION OF LAWS FOR WILD-LIFE PROTECTION

Law enforcement by the Bureau of Biological Survey, undertaken in the interest of wild-life conservation, has to do with administration of the legislation under the migratory-bird treaty of 1916; the

Lacey Act of 1900, governing interstate shipments and foreign importations of wild mammals and birds; laws for the protection of the Federal wild-life refuges under the jurisdiction of the bureau; and, through the Alaska Game Commission, the Alaska game law of 1925.

ACCOMPLISHMENTS UNDER THE MIGRATORY-BIRD TREATY ACT

The treaty between the United States and Great Britain for protection of the birds that migrate between Canada and the United States, was entered into for a 15-year period which ended in 1931. It contained a proviso that it should continue in effect from year to year after the 15-year period had ended. Its benefits to game birds and other migrants have been so evident during the 15 years that the people of both countries have indicated great satisfaction with its provisions. The Bureau of Biological Survey has received few requests of any moment for lessening the restrictions imposed by the treaty or by the act and regulations made to put its provisions in effect.

During the first two years after the ratification of the treaty and before the enactment of the act to give it effect, the Federal migratory-bird law of 1913 continued in force. Regulations under this law had for the first time abolished spring shooting of migratory waterfowl throughout the United States. This abolition permitted waterfowl to nest unmolested in areas from which formerly they had been driven during the breeding season by incessant shooting, and beneficial results were immediately noticeable. The 1913 law, however, was imperfect and could not be satisfactorily enforced, as it conferred on the Department of Agriculture only the power to establish close seasons on hunting migratory birds.

The act to give effect to the migratory-bird treaty was passed on July 3, 1918, and the first regulations under this law were approved on July 31 of the same year. The accomplishments under the new measure may be briefly stated as follows: (1) Continuous protection to migratory insectivorous and other harmless and interesting non-game birds and to certain species of game birds that had become seriously depleted; (2) prohibition of the sale of migratory game birds and of spring shooting; (3) establishment of close-season districts based on the times of migratory flights; (4) establishment of maximum daily bag limits; (5) limiting the methods and means for taking migratory game birds, including restrictions on the size of gun to be used, and prohibiting hunting from airplanes, power or sail boats, and automobiles; (6) restricting the hours of hunting; (7) limiting the number of birds that may be transported in interstate commerce in a calendar week to two days' bag; (8) placing in the close season most of the shore birds; (9) reduction of the bag limits on ducks and geese and limiting the number that may be had in possession; (10) encouragement of the propagation of waterfowl in captivity under permit; and (11) limiting the possession of migratory game birds to a period not exceeding 10 days after the end of the open season.

The most effective Federal action ever taken to promote the maintenance of waterfowl was the prohibition of sale of migratory game birds. This action removed the incentive for commercialized exploi-

tation of these birds by the market gunner. This accomplishment together with the elimination of spring shooting fully justifies the intervention of the United States Government in behalf of the migratory birds of the continent.

ENFORCEMENT PERSONNEL

The enforcement personnel of the Biological Survey under the migratory-bird treaty act has been insufficient to provide adequate administration. The number of United States game wardens, or game protectors, as they are now called, never has exceeded 31. For several years the number has not exceeded 25, a force entirely inadequate to cope with any considerable proportion of violations of the act throughout the United States. This condition was discussed in last year's report, with emphasis placed on the urgent need for an increase. The slight increase in the appropriation for enforcement of the law for the coming year will enable the bureau to employ three or four additional protectors. Although this will provide part of the needed assistance, manifestly the force of game protectors is still far short of the minimum needed, a fact that should be readily apparent when it is recognized that the game-law enforcement personnel in many States greatly exceeds that of the Federal Government for the whole country. The widely recognized inadequacy of this branch of the Federal service adds to the difficulties encountered as it emboldens the lawless element among hunters.

There is imperative need for the employment of regional supervisors who can spend all their time in the field coordinating the work of protectors and cooperators and inspecting conditions affecting wild fowl in various parts of the country.

In addition to doing beneficial work for the birds through the apprehension of actual game law violators, the protectors are influential in an educational way. Their work along this line has been particularly effective in the protection of migratory nongame birds, including insectivorous birds, herons, and others, and in discouraging the traffic in aigrettes and other plumes formerly used in the millinery trade.

LIMITING THE KILL OF WATERFOWL

The amendments to the migratory bird treaty act regulations that reduced the daily bag limits on ducks from 25 to 15 and on geese from 8 to 4, as adopted in December, 1929, were in effect during the past open shooting season. This limitation on the privileges previously permitted the American wildfowler was made necessary by unmistakable indications that the ducks and geese of North America were being seriously reduced by various adverse conditions, including settlement, drainage, shooting, and drought on important breeding grounds. Unfavorable water conditions continued during the 1930 season and there were further alarming indications of decrease in the numbers of ducks wintering in the United States.

Throughout the 1930–31 open season reports were continually coming in from sportsmen who found shooting conditions noticeably worse than in previous years. Game protectors of the Biological Survey, who are constantly visiting the wild-fowl concentration areas, were almost unanimous in their reports of the drying up of

sloughs, ponds, and marshes and the consequent scarcity of ducks. Special investigators confirmed these reports, sometimes finding the birds crowding thickly on such limited water areas as remained. This overcrowding on limited feeding grounds doubtless subjected the already depleted supplies of natural food to a serious drain, and exposed the birds to undue persecution.

Acting upon the information thus gathered, the Secretary of Agriculture, in the spring of 1931, adopted amendments to existing regulations reducing by two weeks the open shooting seasons on waterfowl. In order to give the birds the maximum benefits, the time was taken from the opening end of the season in the Northern States and from the closing end in the South. The amendment had the effect of closing the shooting season on ducks and geese throughout September and after January 15, thus giving a month of additional protection to these birds during the time they remain in this country. An amendment limiting to 10 the number of live goose decoys that may be used at a single gunning stand, which was recommended by the migratory bird treaty act advisory board, was adopted together with other modifications of local importance.

While these additional restrictions have met with some protests, they have received almost general approval from American sportsmen, State game commissions, and other interested organizations. Investigations conducted by qualified observers on the principal central and eastern shooting grounds in 1930 showed that as a rule gunners obeyed the new bag-limit regulation. This attitude bespeaks favorable reception also of the regulation on shorter seasons for the coming fall and winter.

It can not be too frequently or too emphatically stated that, with no practical method of very greatly increasing the production of waterfowl, and with constantly increasing numbers of better-equipped gunners, limitation on the number of birds that may be killed is an unavoidable necessity if extinction of some of the more popular game species is to be avoided. Many sincere individuals throughout the United States hold the opinion that gamekeeper methods on the wild-fowl breeding grounds can be made to increase the production of the birds so materially that game laws and methods for regulating and restricting the annual kill may either be dispensed with or become unimportant as factors in the problem of maintaining an abundance of these birds. Few persons who have not visited the vast, remote regions in the Northwest, where, as a rule, the birds breed in small groups, can realize the practical difficulties in the way of employing gamekeeper methods there for keeping down predatory animals, enemies of wild fowl, or of maintaining hatching and rearing stations adequate for the annual production of 10,000,000 to 15,000,000 ducks—the number generally estimated as the yearly kill in North America. The establishment of sanctuaries for wild fowl, a method known to be effective in maintaining the stocks of game birds and animals, is in fact a modified form of the close-season law or regulation and is similar in purpose and effect. Refuges and sanctuaries on the winter concentration areas are and will be of great benefit to the birds, but their establishment takes so long that they can not be looked to as a remedy for emergency conditions, nor after they are established

will they alone suffice to offset the numbers of birds taken annually by gunners.

Undoubtedly the drought represents a temporary condition, and many of the nonagricultural areas now arid and barren will be restored as good wild-fowl habitat by the return of normal conditions. However, the effect upon the wild fowl may be permanent if there is too great a kill during the emergency period.

EFFECT OF LONG DROUGHT ON WATERFOWL

The northern Plains States, including the region westward to the Cascades, and the Prairie Provinces of Canada are of vital importance to our wild fowl. Though many species breed more or less extensively in other sections, the birds that come to us from these great nesting grounds constitute an essential portion of the supply. If the foundation stock produced there should be wiped out by disastrous drought conditions and overshooting, the purposes of the migratory-bird treaty would be nullified and wildfowling in the United States would suffer seriously. Some of the most highly prized ducks, such as the canvasback and the redhead, breed almost exclusively in this area.

Unfortunately the drought conditions of the 1930 nesting season have shown little sign of improvement. Canadian officials concerned in the administration of the Dominion's migratory birds convention act report light snowfall in vast regions during the past winter and more acute water shortages than in the previous year. In cooperation with Canadian officials representatives of the bureau are continuing investigations on these essential breeding areas.

Water conditions in eastern Canada and northeastern United States have been nearly normal, and throughout the Atlantic coastal regions, the evidences of waterfowl decreases have been less noticeable, especially with reference to the black duck and the blue-winged teal, which breed in some numbers throughout the Northeastern States and the Maritime Provinces. During the season of 1930–31, however, there was a very marked shortage in the numbers of canvasbacks, redheads, and other varieties that nest in the affected area but ordinarily visit in large numbers the great concentration areas of Chesapeake Bay, Currituck Sound, and other famous wildfowl resorts on the Atlantic coast.

EFFECT OF RECENT CHANGES IN REGULATIONS

The reduction of the open season on woodcock to one month and the limitation of the daily bag to four apparently have been effective in enabling this unique game species to maintain reasonably satisfactory numbers at least in the Northeast. Annual investigations by the bureau in New England show the woodcock to be breeding generally in suitable localities, and no immediate alarm as to its future is felt.

Most of the shore birds were placed under the protection of a continuous close season in 1918, because some species were threatened with extinction. The closed period has been effective in bringing about a gradual increase in numbers in most of the varieties, but

these increases are not deemed sufficient to warrant a relaxation of the present restrictions. These birds lay only four eggs annually and on the average probably rear not more than two young.

The wood duck, often referred to as the most beautiful of American waterfowl, has also increased materially under protection, though some are killed by persons who fail to distinguish them from other ducks or who willfully violate the law.

STATE COOPERATION IN PROTECTING WILD LIFE

The States have continued to extend cooperation to the Bureau of Biological Survey in the protection of migratory birds, and 45 States now have enacted legislation making their laws conform wholly or partially to regulations under the Federal migratory-bird treaty act. At recent legislative sessions 7 adopted laws having this effect.

State legislatures and State game officials having regulatory powers have generally found it necessary to restrict the privileges of the individual gunner with respect to upland nonmigratory game to a far greater extent than has been done by Federal regulations governing the taking of migratory game birds. Yet migrant species, because of their greater local concentrations, face more serious losses from shooting and from diseases and other natural causes than threaten many of the nonmigratory species. With a public educated to the seriousness of the situation confronting the waterfowl and other migrant game birds, it is felt that the Federal Government may count upon public sentiment to support whatever measures may be necessary for the protection of the migrant species.

VIOLATIONS OF FEDERAL PROTECTIVE LAWS AND PENALTIES

Handling and disposal of migratory-bird treaty act cases during the year are shown in Table 3. There was an increase of 135 cases over the 303 cases reported for prosecution the preceding year. Of those reported by United States game protectors and deputy game wardens, 58 were not forwarded for Federal prosecution because of lack of sufficient evidence or for other satisfactory reasons. Federal courts imposed fines ranging from $1 to $250, the fines and costs aggregating $5,965. Jail sentences of 9 days to 6 months were imposed in 12 cases, and in 6 cases defendants were placed on probation for 1 to 5 years. Five cases tried before juries resulted in verdicts of guilty.

TABLE 3.—*Cases of violation of the migratory bird treaty act disposed of during the fiscal year 1931, and cases still pending*

Cases disposed of	Number	Cases pending	Number
Convictions	267	Pending from former year	350
Dismissals	83	New cases	438
Verdicts of not guilty	12		
No bills found	5	Total	788
Nolle prosse	37	Disposed of	406
Death of accused	2		
		Pending at end of year	382
Total	406		

Migratory game birds and mounted specimens of an estimated market value of $2,100 were confiscated. Most of the seized game birds fit for use as food were donated to hospitals and other charitable institutions; the mounted specimens were utilized for scientific and educational purposes.

Of the cases reported for prosecution during the year 111 involved the hunting, killing, or possession of species for which no Federal open seasons are prescribed, including game, insectivorous, and other nongame birds, as follows: Game birds: Swan, 6; wood duck, 30; sandhill crane, 1; willet, 1; killdeer, 1; sandpiper, 1; band-tailed pigeon, 2; yellowlegs, 6; avocet, 1. Insectivorous birds: Catbird, 1; thrush, 1; robin, 48; nighthawk (bullbat), 2; meadowlark, 4; flicker, 1. Other nongame birds: Grebe, 1; heron, 3; loon, 1.

Two cases involving hunting from an automobile, one in California and one in Texas, were reported during the year, and one case previously submitted was successfully terminated. Several complaints regarding the hunting of migratory waterfowl from airplanes were received, and evidence was obtained against one person in Colorado and the case forwarded for prosecution. Four other airplane cases, two in Kansas and two in Louisiana, were disposed of by the imposition of fines.

In a jury trial in Federal court at Detroit, Mich., on a charge involving the selling of ducks, the defendant was found guilty, fined $100 and sentenced to two months in jail. Another individual in the same district, adjudged guilty by a jury of a similar offense involving a lesser number of birds, was given the choice of a $250 fine, or a $100 fine and 30 days in jail, and elected to pay the smaller fine and serve the jail sentence. Thirty days in jail was imposed by the Federal court at Baltimore, Md., upon a defendant convicted of shipping to commission merchants wild ducks concealed in improperly marked packages.

The first conviction for killing ducks in excess of the reduced daily bag limit, obtained in Federal court at Sacramento, Calif., on October 9, resulted in a fine of $10 and confiscation of the birds seized. Charged with killing ducks in excess of the daily limit and with possessing more than 30 ducks at one time, two gunners apprehended on the Susquehanna Flats, in Maryland, entered pleas of not guilty in Federal court at Baltimore, but after hearing the evidence the court adjudged them guilty, fining one $150 and the other $50 and costs. A defendant arraigned in Federal court at Jefferson City, Mo., charged with killing one wild duck from a motorboat, entered a plea of guilty and was fined $250.

Among other cases typical of violations committed and showing the reaction of the court thereto may be mentioned the following:

Selling ducks, 30 days in jail, with sentence suspended (Louisiana, 3 cases), and $100 and costs (Wisconsin); killing waterfowl in close season, 9 days in jail (Louisiana); possessing ducks in excess of the daily limit, $100 (Louisiana); possessing ducks in close season, 6 months in jail, placed on probation (Michigan); selling geese, $100 (Missouri); possessing a flicker and a robin, $100 (Ohio); and killing brant in close season, 6 months in jail, placed on 3 years' probation (Virginia).

Seven new cases of violation of the Upper Mississippi River Wild Life and Fish Refuge act were submitted for prosecution. Three of these were terminated, one by a suspended sentence and two by fines of $25 each and costs. Three cases previously reported were dismissed and 7 others were disposed of by fines, 4 of $10 each, 1 of $75, and 2 of $100 each. Nineteen traps and one canoe were ordered confiscated by the court. Reservation rangers apprehended 59 persons who were violating State game laws on the refuge, 31 in Wisconsin and 28 in Minnesota. These cases were terminated by fines and costs aggregating $1,497. Twelve persons found guilty were required to serve jail sentences, 4 of 30 days, 1 of 40, 1 of 50, 5 of 60, and 1 of 75 days. A corporation engaged in construction work in the vicinity of one of the units of the Upper Mississippi Refuge recently paid $1,000 to the United States in a compromise settlement resulting from the unauthorized cutting of timber on the refuge.

Two new cases were filed in Federal court for alleged violation of section 84 of the United States Criminal Code protecting wild animals, including birds and their eggs, on Federal refuges in general. Six cases were closed by fines of $5 to $15 each.

INTERSTATE COMMERCE IN WILD BIRDS AND MAMMALS

Under the Lacey Act, which regulates interstate transportation by common carrier of wild birds and mammals, extensive investigations are conducted by United States game protectors, many of them in response to requests received from State game departments for information regarding particular shipments. Prosecutions for violations of this act are predicated upon infractions of State law. This is a valuable form of conservational cooperation with the States, and through the bureau's activities many violations of State laws pertaining to traffic in pelts of fur-bearing animals were discovered. Progress has been made in discouraging violations, with notable improvement of conditions in some sections.

Information regarding 5,450 shipments that apparently contained skins illegally taken or transported was submitted to State game officials during the year. The several States closed by prosecution 940 cases based on information originally furnished by the Bureau of Biological Survey in which the aggregate of fines assessed was $17,312, and the costs $3,335, a total of $20,647. Jail sentences of 3 to 40 days each were imposed against six violators.

With respect to illegal interstate shipment of the dead bodies or parts of wild animals, the Federal Government could more effectively aid the States if the Lacey Act were amended to broaden its scope, particularly to include interstate transportation by means other than common carrier—and to confer authority on Federal officials for the seizure of illegal shipments.

Another type of cooperation that has been tendered by the Bureau of Biological Survey and has proved beneficial to many of the States deals with violations of State fish and game laws in addition to illegal shipments. Other violations of State laws were reported in 31 States, and the prosecutions instituted in 631 cases resulted in the imposition of fines and costs aggregating $17,076.

PERMITS TO POSSESS WATERFOWL AND OTHER MIGRATORY BIRDS

The regulations under the migratory-bird treaty act provide for the issuance of permits to individuals to take and possess specimens of migratory birds for legitimate scientific and educational purposes; also, to take, possess, buy, sell, and transport waterfowl for breeding purposes, and to sell for food the carcasses of waterfowl bred in captivity. The total number of permits outstanding on June 30 was as follows: Scientific collecting, 2,072; scientific possession, or taxidermist, 422; special scientific possession, 920; bird banding, 2,041; propagation (possession and sale), 4,243. In addition, permits were issued to 123 persons to capture stated numbers of wild waterfowl for breeding purposes.

An examination of the reports of operations submitted shows that during the calendar year 1930 the following waterfowl were raised in captivity: Mallard ducks, 67,860; other ducks (including 9 coots), chiefly black ducks, wood ducks, and teal, 1,080; geese (including 2 brant), 4,993; total, 73,933.

The total number of wild ducks of all kinds raised in captivity, as indicated by reports covering operations in 1930, is 68,931, an increase of 9,746 over the number raised during the preceding year. The 4,991 geese raised is an increase of 1,257 over the number raised during the previous year. Of the total, 14,897 ducks and 46 geese were sold for food during the year, and 9,734 ducks and 3,359 geese were sold for propagating purposes.

CONSERVATION THROUGH INFORMATIONAL WORK

As in previous years, the Bureau of Biological Survey has maintained the most cordial relations with the various State game departments, and has cooperated as far as its resources would permit in the dissemination of information gathered by its field operatives and by voluntary collaborators concerning wild-life conditions throughout the country. It has continued its educational activities in game conservation by press and radio statements, direct correspondence, and bulletins. The press of the country has given wide publicity to the bureau's statements on wild life, and the annual poster on open seasons for game was reproduced in the leading sporting periodicals of the country, one of which purchased copies for distribution to its subscribers as a supplement. This poster (No. 49–Bi) was also prominently displayed in post offices of the third and fourth classes in the principal waterfowl States.

Other publications on conservation matters issued by the Biological Survey during the year were the annual bulletins on the game and fur laws (Farmers' Bulletins Nos. 1647 and 1648, respectively), the directory of officials and organizations concerned with bird and game protection (Miscellaneous Publication No. 92), and the text of Federal laws and regulations for the protection of migratory birds (S. R. A., B. S. 72). The bulletins on game and fur laws present in concise form the open seasons on migratory and upland game birds, game animals, and fur bearers. They also give a résumé of legislation affecting wild life in the various States and Provinces and set forth the provisions of Federal, Canadian, and other laws concerning daily bag and possession limits, hunting and fishing licenses, shipment, sale, possession, and other matters relating to

game. These bulletins are in constant demand and are given wide distribution, special efforts being made to place them in the hands of interested organizations and individuals. The directory of game-protection officials and organizations lists the names and addresses of Federal, State, Canadian, and Mexican officials charged with game-law enforcement and the officers of conservation and sportsmen's organizations of State-wide and national importance, both in the United States and the neighboring countries. The directory, like the game and fur law bulletins, is widely distributed, and has proved to be of great value to those interested in the coordination of game conservation. In bringing to the attention of the public the need for greater conservation of our wild-life resources, the Biological Survey has also made use of motion pictures and wild-life exhibits at sportsmen's shows and conventions.

SENATE COMMITTEE ON WILD-LIFE RESOURCES

The Bureau of Biological Survey actively participated during the year in the studies and investigations conducted by the Senate Special Committee on Wild Life Resources. This committee, originally appointed to investigate matters relating to the wild-life resources of the nation, and to determine the most appropriate means of conservation and replacement, continued and intensified the studies commenced during the preceding year and called upon this bureau for assistance and information. The committee's first report was published on January 21, 1931. (S. Rept. No. 1329, 71st Cong., 3d session.) Representatives of the Bureau of Biological Survey accompanied members of the committee in various parts of the United States and collaborated in investigations of the elk situation in the Jackson Hole country in Wyoming; of the wild-life conditions on the Upper Mississippi River Wild Life and Fish Refuge, and in the Superior National Forest and the lake region of northern Minnesota; of the conditions affecting the deer in the Kaibab National Forest, Ariz.; and of the desirability of establishing a wild-life refuge in the Okefenokee Swamp region in southern Georgia. Representatives of the bureau also advised with the committee and aided in planning a visit to Alaska during the summer of 1931 for the purpose of gaining first-hand information on conditions affecting game and fur animals and other wild life in the Territory. The interest of the committee in devising a comprehensive program for conservation of bird and animal life will be a distinct aid to the bureau in its work in behalf of the wild-life resources of the country.

ALASKAN WILD LIFE

AMENDMENT TO THE ALASKA GAME LAW

By act of February 14, 1931, a number of amendments were made to the Alaska game law, all of which had been recommended by the Alaska Game Commission and approved by the Bureau of Biological Survey.

The amendments clarified a number of provisions of the act of January 13, 1925, including matters pertaining to ownership of game and fur animals escaped from captivity, definitions of game

animals and birds to include introduced species, police powers of the enforcement personnel, protection of government property used by the Alaska Game Commission, and resident hunting, trapping, and fur dealers' licenses. Penalties for violations were given uniform application and were increased by providing that licenses shall be forfeited on second or subsequent convictions and that contraband game mammals, birds, and furs shall be confiscated. Officers, agents, and employees of the commission were authorized to administer oaths required, and the executive officer was relieved of certain responsibilities in connection with the receipt and disbursement of funds under the Alaska game law.

CHANGES IN ALASKA REGULATIONS

FUR-BEARING ANIMALS

The principal amendment to the regulations under the Alaska game law redistricted the Territory into eight instead of three fur districts, the new boundaries following so far as possible those natural barriers of the Territory that influence climatic conditions and hence have a bearing on the priming of furs. Slight variations were made in the seasons in accordance with the boundaries of the new districts. For the relief of trappers, who had suffered hardships because of low prices and scarcity of other furs, local trapping of beavers and martens, with seasonal limits of 10 each, was permitted in the spring of 1931. To restrict illegal trapping and marketing, skins of beavers and martens, taken during the open season or imported, were required to be tagged with seals of the commission. Except in the localities where trapping was permitted, beavers and martens had not increased sufficiently to allow it, and without the seasonal limit and the requirement that the skins be sealed, no trapping could have been permitted without menacing the basic stocks of these animals. Through careful management the commission was able to handle the sealing of these skins with a minimum of complaint and inconvenience to the trappers.

ALASKAN BROWN BEAR

The protection of the Alaskan brown bear, which had been widely discussed during the year, received the attention of the Alaska Game Commission when it drew up its recommendations for amendments to the regulations. Though it considered that the previous regulations were sufficient safeguards to the species, the commission decided that it could well recommend the extension of protection to these animals in two additional extensive areas without increasing the hazards to human life and property. One of these new areas is on the north side of Kodiak Island, and the other is on the Kenai Peninsula west of the Kenai Mountains. The boundaries of all these areas are clearly set forth in the amended regulations. (Circular No. 8 of the Alaskan Game Commission.)

As in other restricted areas, the hunting of brown bears, by either residents or nonresidents, is limited to the open season, September 1 to June 20, except that residents at any time may kill bears to protect life or property. As heretofore the season throughout the

Territory when nonresidents or aliens may hunt large brown or grizzly bears is the same as that in the restricted area for hunting by residents. For nonresidents substantial license fees are prescribd by the act.

Extension of protection to these big bears should constitute an assurance that the resident game commission is thoroughly conversant with the needs of Alaskan wild life and can be relied upon to recommend protection for the perpetuation of the species as conditions warrant. The wild life of Alaska is one of the major resources of the Territory, and many of the natives and residents are dependent upon its maintenance for income, food, and clothing. The vastness of Alaska is seldom visualized by persons who have not traveled there. Its territorial area of almost a fifth that of continental United States, is sparsely populated by slightly fewer than 59,000 persons, who are about equally divided between whites and natives, including Indians and Eskimos. The climate, the colossal mountain ranges, and the turbulent streams render enormous areas of the Territory virtual sanctuaries where wild life is practically undisturbed by man.

EXPORTS OF PELTS

Reports compiled by the Alaskan Game Commission indicate that skins of land fur-bearing animals totaling 595,547, and valued at $2,128,148, were exported from the Territory during 1930. This is $2,385,715 less than the value of the 1929 shipments, although 197,245 more pelts were exported. The smaller return for 1930 resulted from a general decline in the market value of individual furs. The exportation of muskrat skins in 1930 exceeded by far that of any other species, and comprised more than 80 per cent of the total. Slight increases were shown in exports of otter, mink, black and glacier bear, polar bear, silver fox, black fox, and marten pelts, but those of other species showed a marked decrease.

IMPORTATIONS OF FOREIGN SPECIES OF WILD LIFE

FOREIGN PROTECTED SPECIES

Section 527 of the tariff act of 1930 provides that when a foreign State or Province affords special protection for any animals or birds, such species may not be imported into the United States except under a certificate of the United States consul at the port of shipment showing that all necessary permits and requirements have been complied with; otherwise the shipment is subject to seizure and disposal. Regulations for carrying this provision into effect were promulgated by the Secretary of the Treasury under date of November 26, 1930, and since then several orders covering special cases have been published in the Treasury Decisions. These are as follows:

T. D. 44407, prohibiting the importation of tinamous from Argentina.

T. D. 44412, prohibiting the importation of wild mammals and birds in violation of foreign law.

T. D. 44413, prohibiting the importation of koala bearskins from Australia.

T. D. 44436, prohibiting the importation of tinamous, commonly known as codornices and perdices, from Uruguay.

T. D. 44437, prohibiting the importation of nutria pelts from Uruguay.
T. D. 44438, prohibiting the importation of the quetzal bird from Guatemala.

One of the objects of this legislation is to restrict the importation of tinamous from Argentina, which had for several years prohibited their exportation. The importation of these birds for market purposes had reached several hundred thousand and had assumed the proportions of a considerable trade, but during the past year this trade fell off and few if any importations were made. Whether or or not this has been due to the regulations under the tariff act, the fact remains that the restrictions on export by Argentina and on import by the United States have rendered the traffic unprofitable, and commercial shipments have practically ceased.

If this legislation had accomplished nothing else it would have been well worth the effort required for its enactment. But in addition the Treasury Department orders have had the effect of curtailing raids on the rookeries of fur seals and sea elephants on Guadalupe Island off the west coast of Mexico by preventing the entry of the animals for exhibition, except when authorized by the Mexican Government, and also of restricting shipments of skins of certain marsupials from Australia and of nutria from Uruguay. In short, when any foreign government gives special protection to any species of its fauna, the United States is now in a position to cooperate extensively in preventing the marketing of such species in this country.

DANGEROUS SPECIES

Regarding prohibited species, more correspondence has developed than for some years past. Four mongooses consigned to Houston, Tex., were reported on a vessel early in April, but two died en route and the others were immediately destroyed upon arrival. Applications for permits for the entry of European hares and several other doubtful species failed to receive favorable action.

In July, 1930, a small colony of Indian mynas (*Acridotheres tristis*) was discovered in the city of Los Angeles, some of the birds nesting under the eaves of a residence. Through prompt action on the part of the local authorities the birds were destroyed, and apparently the colony was wiped out. Investigation showed that these birds had been brought from Hawaii for an aviary in Los Angeles and subsequently liberated.

Acting on this case the California Bureau of Plant Quarantine and Pest Control took action to strengthen the local law and to insure that further shipments of the kind should not gain entrance to the State. Permits have not been issued for these or for crested mynas (*Aethiopsar cristatellus*) for several years, but at least two shipments of birds containing a few crested mynas arrived at San Francisco and in both cases the birds were destroyed.

Since the crested myna has gained a foothold in British Columbia it may spread to the Pacific Coast States, but so far as known it has not yet crossed the boundary. California is taking steps to prevent any from being brought in through the ports in that State.

PERMITS AND INSPECTIONS

The number of importation permits issued during the year was 1,229, an increase of 24 over that of the preceding year, and the in-

spection of shipments at various ports of entry increased from 484 to 502. These figures, however, are smaller than those for 1929. In addition, 22 permits were issued at Honolulu, Hawaii, for the entry of 252 miscellaneous birds. The total number of all foreign birds imported was 658,892, of which 2,764 were without permit, many of them being brought in under declaration of passengers' baggage. Importations under permit comprised 525,429 canaries, 38,595 parrots, 39,712 quail, and 52,392 representatives of miscellaneous species.

MAMMALS IMPORTED

Mammals of many kinds are imported for various purposes, those of most interest during the year being foxes, bears, and monkeys.

FOXES

The number of foxes imported from Canada, 559, showed a marked decrease in comparison with the figures for 1925, when more than 8,000 were entered. Most of the foxes come from Prince Edward Island and enter at Vanceboro, Me., or Detroit, Mich., but a few come in at ports in Washington State. The great decline in fur prices no doubt had something to do with the decrease, but probably also the demand for breeding stock is now largely supplied by animals bred in the United States, and importations are confined mainly to the introduction of animals intended to furnish new blood on fox farms already established.

BEARS

The importation of bears has shown a marked increase during recent years. Most of the arrivals are black bears, but occasionally grizzlies, Alaskan brown bears, or polar bears are brought in. Black bear cubs from Canada have proved unusually attractive during the past year, as shown by the issue of permits for more than 95 shipments authorizing the entry of 170. Some of these cubs were only a few months old and were brought in for exhibition purposes. Most of them are shipped from Winnipeg, Manitoba, and cross the line at Noyes, Minn., en route to Eastern States, chiefly New York, New Jersey, and Pennsylvania.

These entries emphasize a marked change in the attitude of the public toward bears during the past century. In 1830 Maine began the payment of bounties to encourage the destruction of black bears, and was followed shortly by New Hampshire and New York. These bounties continued with some interruption for many years. Apparently the first protection given black bears by a close season was in New York in 1904; and last year similar protection was in effect in 19 States, two of them, Mississippi and Wisconsin, protecting bears throughout the year. The importance of the black bear as a game animal, as an exhibit in zoological gardens, or as a pet has caused an almost complete reversal in legislation, and instead of bounties being paid generally for its destruction the species is now not only protected in many States but is being increased in numbers by importations.

MONKEYS

Monkeys of many species are brought to this country every year for exhibition and experimental purposes, and include representatives of all the large apes, such as gorillas, chimpanzees, orangutans, and gibbons, a number of Old World forms, and a smaller number of species from tropical America. The total number of gorillas brought in, including 3 en route at the close of the year, was 15. Of the Old World monkeys, by far the greater number are the common rhesus monkeys from India, of which shipments of several hundred occasionally come in. These are intended chiefly for exhibition, but many are used for laboratory purposes. The total imports for the year aggregated 4,214, most of the animals coming from Calcutta or other Indian ports, but some by way of Singapore and Japan. During the winter a considerable number of squirrel monkeys (marmosets) of several species arrived from various parts of tropical America to supply the demands of the holiday trade. As a rule these monkeys are short lived, but one or two species are fairly hardy. They make excellent pets and sometimes are quite popular.

GAME BIRDS

TARIFF REGULATIONS

Under the provisions of the new tariff act of June 17, 1930, game birds for propagation are admitted free of duty, and regulations to carry out this provision were issued by the Bureau of Customs under date of December 25, 1930. These regulations define game birds and limit them to four groups: The waterfowl (Anatidae); quail, grouse, and turkeys (Gallinae); bustards (Otididae); and tinamous (Tinamidae). Game birds imported for commercial purposes and not by game commissions or individuals for stocking are still subject to duty unless it can be shown to the satisfaction of officers of the customs that they are intended for propagation. The removal of duty resulted in an increase in the number of Hungarian partridges.

MEXICAN QUAIL

Under the tariff regulations all quail imported from Mexico this year were entered free of duty for the first time since 1922, when the first tariff of 50 cents a bird was placed on them. In 1925 this duty was reduced by Executive order to 25 cents.

Under a provision of the tariff act importers of quail were obliged to obtain, this year, in addition to export permits from the Mexican authorities, consular certificates from the United States consul for the district from which shipment was made, showing that the birds were exported in accordance with local laws and regulations.

Notwithstanding the removal of duty the entries of quail showed a marked decrease from the numbers imported in previous years. The outlook prior to the opening of the season indicated that shipments in 1931 would exceed all previous records, as concessions had been granted by the Mexican authorities to 13 individuals for the export of more than 260,000 birds. Only five concessionaires, however, made any shipments during the season, and the total number of birds en-

tered was only 39,712, as compared with 90,124 in 1930. Nearly half the total number, 18,078, entered at Laredo; 16,052 at Brownsville; and 5,582 at Eagle Pass. Most of the birds were shipped to 11 States chiefly in the South and Southwest as follows: Oklahoma, 10,301; Texas, 6,296; Maryland, 4,120; Arkansas, 3,364; South Carolina, 3,118; North Carolina, 2,765; Delaware, 1,997; Georgia, 1,802; New York, 1,462; Mississippi, 1,424; and Florida, 1,273. Several small shipments, totaling about 1,335 birds, went to various States. According to the importers, the decrease this year was due to the fact that heavy rains during the winter made capture difficult. No disease was reported in any of the shipments.

The total number imported from Mexico during the 20 years that quail have been admitted under permit is 653,023.

Most of the quail imported from Mexico are bobwhites, although from time to time a few scaled quail, or cotton tops, and still fewer Massena quail, are brought in. The bobwhite is the Texas bobwhite (*Colinus virginianus texanus*), a form that ranges from southern Texas south through northeastern Coahuila and Nuevo Leon to central Tamaulipas, in Mexico. Most of the birds and those best adapted for restocking in the United States are obtained along the eastern slope of the table-land of Mexico. Some few birds have been shipped from the region of Tampico, but quail from the tropical lowlands of Nuevo Leon and southern Tamaulipas are less desirable for introduction in the United States.

HUNGARIAN PARTRIDGES

Continued interest in Hungarian partridges is shown by the importation of 20,000 this year as compared with 5,453 in 1930. Regular importation of these birds began about 25 years ago, when 864 were entered in 1906 and 3,075 in 1907. Shipments increased until 1914, when the number reached 36,760, and the total for the decade ending in 1915 was 174,295. During the war and for a few years thereafter large shipments ceased entirely and only small consignments were received. In 1924 the number imported reached 4,196; in 1925, 3,044; in 1926, 11,839; in 1927, 5,518; in 1928, 12,620; in 1929, 28,517; in 1930, 5,453; and in 1931, 20,000. Thus the total number of partridges brought in during the 18 years for which records are available is in excess of 265,000. These birds have sold at varying prices, depending on the year, the number imported, and the seasonal price prevailing, but it is safe to estimate that the actual cost of the breeding stock delivered at destination has been close to a million dollars.

As a result of the various experiments, Hungarian partridges have now become acclimated in some of the States, and in limited areas have increased sufficiently to permit a short open season. During 1930 the season was opened for a few days in some of the counties of Idaho, Ohio, Oregon, and South Dakota, and possibly one or two other States.

AVIARY AND EXHIBITION SPECIES

In addition to game birds brought in for restocking, a number of rare pheasants were imported for exhibition or aviary purposes during the year. Among these may be mentioned 26 Argus pheasants

(*Argusianus argus*), 28 copper pheasants (*Phasianus soemmerringi*), 11 Impeyan pheasants (*Lophophorus impeyanus*), 2 Elliot's pheasants (*Syrmaticus ellioti*), 5 mikado pheasants (*S. mikado*), 27 fireback pheasants (*Lophura rufa*), 15 Siamese crested firebacks (*L. diardi*), 5 Bornean crested firebacks (*L. ignita*), and 18 Malay crestless firebacks (*Acomus erythrophthalmus*).

A shipment of 37 bamboo partridges (*Arboricola crudigularis*) from Yokohama and 11 bamboo partridges of another species (*Bambusicola thoracica*) from Kobe, Japan, and later 2 wood partridges (*Rollulus roulroul*) from Singapore, were entered at San Francisco

CAGE BIRDS

PARROTS

The importation of cage birds failed to show much increase this year because of the comparatively small number of parrots brought in. Prohibition of the entry of parrots under the Executive order of January 24, 1930, was modified on October 29 so that parrots in shipments of 100 or less might be entered subject to 15 days' quarantine at certain ports where quarantine facilities are available. The number of birds in a crate is limited to 10 parrots or 25 parrakeets, but five birds or fewer that have not been exposed to disease and are accompanied by their owners may be brought in without being quarantined.

Notwithstanding the modification in the prohibition, comparatively few parrots were imported, as quarantine seems to have effectually deterred larger importations. Two shipments were refused entry by the health officers on account of overcrowding and improper packing. The necessity for continuing the restrictions was due to the recurrence of several cases of so-called parrot fever during the year. Among these were five cases, one fatal, at Brooklyn, N. Y., among persons who had come in contact with love birds brought from Habana, Cuba, on December 31, 1930. A man who had cared for two of the birds became sick on January 13 and died five days later. Shortly afterwards four women relatives who had been exposed to the same birds also became ill. Most of the parrots imported were Amazons (*Amazona auripalliata*), but there were also some Panama parrots (*A. panamensis*) and Eclectus parrots (*Eclectus roratus*).

The limitation of 25 birds to a crate seems also to have reduced the importation of parrakeets, particularly Australian grass parrakeets. Many of these birds are now raised in captivity in California, and to some extent the trade has been supplied from this source. A few of the blue, yellow, and other shades of the domesticated forms were imported from abroad. The popularity of love birds of the genus Agapornis continues, and as usual several species were imported.

CANARIES

The importation of canaries during the past season was fairly satisfactory from the standpoint of the cage-bird trade. Considerable numbers were brought in, and on November 7 a shipment containing 10,442 birds arrived at the port of New York.

OTHER CAGE BIRDS

Among the more noteworthy of the rare birds imported during the year may be mentioned 2 crested penguins (*Catarrhactes pachyrhynchus*), 2 cape penguins (*Spheniscus demersus*), several Lilford cranes (*Grus lilfordi*), 1 hornbill (*Lophoceros erythrorkynchus*), 4 Spix's macaws (*Cyanopsittacus spixi*), 2 turquoisine parrakeets (*Neophema pulchella*), 5 elegant grass parrakeets (*Neonanodes elegans*), 1 bell bird (*Procnias nudicollis*), 1 Venezuelan tanager (*Schistochlamys atra*), and 1 Venezuelan thrush (*Platycichla venezuelensis*).

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